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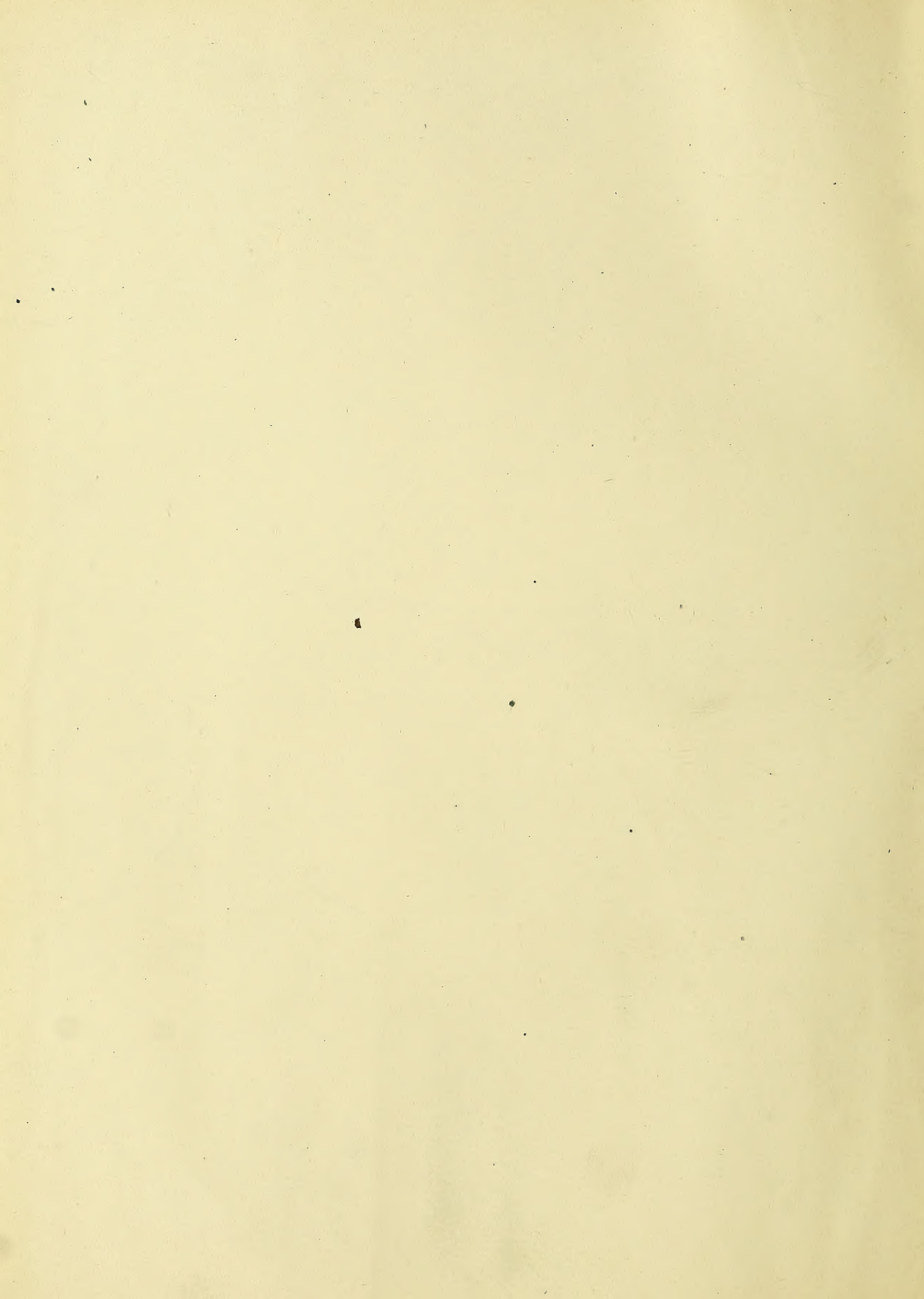
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# REPORT

ON

# CHOLERA IN EUROPE AND INDIA,

BY

EDWARD O. SHAKESPEARE, OF PHILADELPHIA, A. M., M. D., PH. D.,  
UNITED STATES COMMISSIONER.



WASHINGTON:  
GOVERNMENT PRINTING OFFICE.  
1890.



24536

## EXECUTIVE ORDER.

BY THE PRESIDENT OF THE UNITED STATES OF AMERICA.

### EXECUTIVE ORDER.

Whereas, by a provision of the act of Congress entitled "An act making appropriations for sundry civil expenses of the Government for the fiscal year ending June 30, 1886, and for other purposes," approved March 3, 1885, for the suppression of epidemic diseases, the President of the United States is authorized, in case of threatened or actual epidemic of cholera or yellow fever, to use certain appropriated sums made immediately available, "in aid of State and local boards or otherwise, in his discretion, in preventing and suppressing the spread of the same, for maintaining a quarantine and maritime inspection at points of danger;" and

Whereas there is imminent danger of a recurrence of a cholera epidemic in Europe which may be brought to our shores unless adequate measures of international or local quarantine inspections are taken in season; which measures of preventive inspection are proper subjects to be considered, and to the end that their efficiency in divers countries may be secured:

Now, therefore, in virtue of the discretionary power conferred upon me by the aforesaid act of Congress, I designate and appoint E. O. Shakespeare, M. D., of Pennsylvania, as a representative of the Government of the United States, to proceed, under the direction of the Secretary of State, to Spain and such other countries of Europe where the cholera exists, and make investigation of the causes, progress, and proper prevention and cure of the said disease, in order that a full report may be made of them to Congress during the next ensuing session; and I direct that the necessary expenses of travel and sojourn of the said E. O. Shakespeare in proceeding from Washington to Spain and elsewhere in Europe as he may find it absolutely necessary to go in pursuit of the desired information and in returning to Washington at the conclusion of his labors, be adjusted and paid from the appropriation and available under the aforesaid act of March 3, 1885, upon his statement of account approved by the Secretary of State.

Done at the city of Washington this first day of October, in the year of our Lord one thousand eight hundred and eighty-five, and of the Independence of the United States the one hundred and tenth.

GROVER CLEVELAND.

By the President:

T. F. BAYARD,

*Secretary of State.*





## LETTER OF TRANSMITTAL.

PHILADELPHIA November 17, 1890.

The Hon. JAMES G. BLAINE,  
*Secretary of State:*

SIR: In accordance with instructions I have the honor now to transmit my official report on cholera in Europe and India in relation to the last great widespread epidemic. I was directed by his excellency the President, during the early part of the autumn of 1885, to proceed to Europe and prosecute in the various countries which were then experiencing the ravages of the disease, or had recently suffered from them, such investigations into the cause, prevention, and cure of Asiatic cholera as my judgment would suggest.

Upon my arrival in Europe pursuant to this commission I found that cholera was rapidly vanishing from that continent, for the season at least, and I learned that the field for most active observation was then in Palermo, the principal city of the island of Sicily.

After equipping myself with a traveling laboratory, purchased in Berlin, and familiarizing myself in that city with the characteristics of the so-called "comma bacillus of Koch," through the courtesy of Dr. Robert Koch, professor of hygiene at the University of Berlin, and Dr. Georg Gaffky, director of the Pathological Laboratory of the Imperial Board of Health at Berlin, whose kindness I take this public opportunity to gratefully acknowledge, I went at once to Palermo, where a severe epidemic of cholera was raging, and began my work of investigation and experiment. I deem it fitting at this point also to express my high appreciation of the constant courtesy extended me by his excellency the Count of Bardessono, prefect of Palermo, who lost no opportunity to facilitate in every manner possible my researches everywhere within the limits of his prefecture. I should also mention the ready assistance I received in the Kingdom of Italy at the hands of many officials and physicians, who kindly placed themselves and their knowledge at my service.

After the epidemic was ended at Palermo I next turned towards Spain, gaining information relating to the ravages of the epidemic in the various cities of Italy traversed en route by rail from Naples to Marseilles, from which latter port I sailed for Barcelona, reaching that northern Mediterranean port of Spain in the first days of January, 1886.

When I arrived in Spain cholera had virtually disappeared from the Kingdom; it still lingered, however, in the form of local epidemics in one or two of the southern provinces near the Straits of Gibraltar. Because of the great extent and severity of the Spanish epidemic of 1885, as well as on account of the very large number of so-called anti-choleraic inoculations which had been practiced in that country by Dr. Jaime Ferrán and his assistants as a measure of prevention, and had been proposed in the Spanish Cortes by Señor Castellar as a substitute for quarantines and cordons sanitaires as more effective and less hurtful to trade than the latter, I was of the opinion that the course of cholera in Spain presented to me the best opportunity of making as thorough a study of the disease as was in my power.

I visited many towns, in nearly every province of Spain where cholera had spread widely, endeavoring to obtain by personal contact with the inhabitants of high and low station and intelligence a fundamental knowledge of the circumstances of life, manners and customs, and



hygienic conditions, general and individual, which might bear upon the mode of introduction and spread of cholera among them. Especial attention was given to the matter of water-supply and the disposal of household offal. In the round of these personal observations I encountered and spent some time in the midst of a quite severe epidemic, during the month of February, in the ancient walled town of Tarifa, on the northern shore of the Straits of Gibraltar.

In addition to the above-mentioned personal observations, I succeeded in making an agreement with the custodian of a large number of official replies, from villages and towns in Spain which had felt the weight of the scourge, to a series of interrogatories relating to the course of cholera and the hygienic conditions addressed to them by the director-general of hygiene and sanitation under authority of the Minister of the Interior, through which I obtained a careful analysis of numerous and important data concerning the epidemic and the hygienic conditions in upwards of five hundred cholera-stricken towns. I have introduced these data in this report in full in order that those of my countrymen so disposed may have the opportunity of studying these questions as near as possible to the original sources of information. Those who care only for general results will find a summary of the principal points elicited by the analysis. I also prepared a series of twenty-five questions bearing upon every important aspect of the mode of introduction and spread as well as of the means of prevention of cholera, and had addressed this circular letter to twenty-five hundred physicians scattered among the Spanish communities which had suffered from cholera before I had learned that the Spanish Government had issued a somewhat similar series of interrogatories. The numerous replies to my own questions were added to and analyzed with the above-mentioned official documents of the Spanish Government.

I have, furthermore obtained and placed in this report official statistics and documents relating to the so-called anti-choleraic inoculations in Spain in order that the most important of the evidence concerning this question may be accessible, as nearly as possible in its original form, to American physicians. I am pleased to have the occasion, before passing from the consideration of cholera in Spain, to express in this place my hearty acknowledgments of the universal courtesy with which the objects of my mission were received and aided by the officers of the Spanish Government, general, provincial, and municipal, as well as by the local physicians.

After leaving Spain, in April, 1886, authority was requested and obtained to proceed to India for the purpose of prosecuting researches in the native home of cholera. I reached India in the commencement of June, and departed thence for America in August. Although, unfortunately, I entirely lost, for work, the first month of my sojourn in India by reason of serious illness due to the prostrating influences of the summer climate upon the unacclimated foreigner, and suffered from ill health during the remainder of my time in that country, I was able to undertake some observations in Bengal, mainly in the city and suburbs of Calcutta. Through the kindness of his excellency, the Viceroy of India, I found every avenue of research open and willing officers ready to forward my aims.

I returned to America in the autumn of 1886, after a year's absence, so much shattered in health—the result of my Indian experience—that it was impossible to commence active work upon the preparation of my report until the end of the following winter.

This report comprises, exclusive of a list of authors, table of contents, index, illustrations, etc., eight hundred and ninety-nine quarto pages of matter solidly printed. It contains one hundred and five illustrations, most of which were made by the author himself. These illustrations comprise forty photo-micrographs, taken with the microscopical lens, all but six of them being made by the writer, who was obliged to acquire the art of photography in order to produce them, because he could get no one to do this troublesome work. Numerous analytical charts and tables relating to cholera statistics have been prepared and incorporated. A full table of contents and a cross index have been added, comprising forty-five pages, which it is hoped will considerably facilitate reference to the data contained herein.

The work of foreign investigation, continuing one year, and the labor of preparation and of supervising the printing of this report, lasting four years—all voluntary and entirely without

pay for personal service—have proceeded to completion with a few much regretted interruptions which were unavoidable by reason of the imperative exactions of private affairs. If in view of the amount of personal labor expended, his countrymen exonerate the writer from the blame of unreasonable delay, and they ultimately receive any benefit derived through this labor, he shall have received a sufficient reward.

Finally, the author desires to convey his thanks to his friends Prof. George A. Piersol, of the University of Pennsylvania, and Dr. William M. Gray, of the Army Medical Museum at Washington, to the diligence and skill of each of whom he is indebted for the use of three of the photographic negatives from which corresponding illustrations have been produced.

I have the honor to be, sir, very respectfully, your obedient servant,

EDWARD O. SHAKESPEARE.





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\* Illustrations No. 2 A, B, and C, should be read No. 3 A, B, and C. Illustration No. 3 should be read No. 2.



## INTRODUCTION

The last epidemic of cholera which has visited Europe appears to have reached Egypt on its way from India in the year 1883, where, as at present known, it suddenly and unexpectedly exploded in the town of Damietta in Lower Egypt, committing great ravages. Past experience with this dreaded disease caused great alarm in the various European countries bordering upon the Mediterranean, and two of the great powers of Europe dispatched official commissions to Egypt for the purpose of investigating the origin and spread of the epidemic, particularly with the view of making new observations concerning the etiology and prophylaxis of the disease. The French Government sent its most experienced pathologists and bacteriologists, and the German Government likewise commissioned three experienced investigators of the causes of disease, placing Dr. Robert Koch, then director of the Pathological Laboratory of the Imperial Board of Health at Berlin, at the head of that commission. These two commissions reached the field of their labors in Egypt about the same period, and their investigations were conducted, so to speak, side by side. The medical world was exceedingly excited a short time after the arrival in Egypt of the German commission by the announcement from Dr. Koch to his Government of the discovery in the intestinal contents of choleraic patients of a peculiar micro-organism having special characters which distinguish it from all other bacteria, and which he thought there was reason to believe might be the active germ or cause of cholera. Because of the high reputation as bacteriologist and original investigator which Dr. Koch occupied, and because among the numerous announcements of previous discoveries which he had made there was not one which had subsequently failed of confirmation by other investigators, this announcement at once commanded the attention of the medical world.

At the time that these announcements of the German commission were being published in the medical and lay press of Europe, the French commission issued bulletins announcing a supposed discovery on their part concerning the existence in the blood of choleraic patients of peculiar elements, and making at the same time counterstatements to those of the German commission regarding the micro-organisms of the intestines.

The German commission did not reach the scene of their labors in Egypt until the commencement of the autumn of 1883, and the epidemic soon ended, leaving them without sufficient material with which to bring their investigations to a satisfactory termination. But in response to an earnest petition from them they were sent to India by the German Government for the purpose of continuing their researches.

They reached India in the middle of the autumn, and conducted their investigations mainly at Calcutta during the remainder of the fall and the early part of the winter. Upon resuming their work in Hindustan, they at once were able to confirm the announcements which they had previously made from Cairo as to the presence in the intestinal contents of this peculiar micro-organism, and as their work continued their observations only seemed more certainly to establish the truth of their first announcements. In upwards of one hundred autopsies and cases of cholera they did not fail a single time to find these minute organisms. They also made a large series of control observations in order to satisfy themselves as to their presence or absence in other diseases or in other conditions. The failure to find them in any other cases than those of Asiatic cholera confirmed the opinion which they had previously arrived at, viz, that not only are these micro-organisms always to be met with during certain



stages of genuine cholera, but that they are peculiar to the disease, and have a certain close and specific relation with it. In subsequent dispatches to the German Government they claimed that with this discovery of a peculiar and characteristic micro-organism always to be found in Asiatic cholera, and associated with no other disease, they had furnished a sure and easily recognizable diagnostic sign.

The German commission further occupied themselves while in India with experiments upon animals for the purpose of producing the disease if possible by inoculations of pure cultures of these micro-organisms. But after performing numerous experiments upon various domestic animals (including the dog, rabbit, guinea-pig, monkey, and mouse) they were unsuccessful in these attempts, and consequently left the question of the etiological relation of these minute organisms to Asiatic cholera still undetermined. They expressed their belief, however, that their constant presence in cases of cholera in those parts of the body which are the seat of the invasion of the disease, and their entire absence in all other diseases afforded strong ground for assuming that they should be regarded, not only as a diagnostic sign of genuine cholera, but also should be looked upon as the active cause of the disease.

The claims of the German commission were, therefore, twofold in their character: first, from the stand-point of diagnosis; second, from the stand-point of etiology.

The further work of the German commission in India was not rewarded by the positive results of experiments upon animals. Nevertheless the etiological relation of these minute organisms to Asiatic cholera occasioned the liveliest interest in Europe among the Governments most interested in the question of quarantine.

The British Government soon sent to India a commission, with Dr. E. Klein at its head, for the purpose of investigating the grounds of the opinions announced by the German commission. After having spent some time in Calcutta and Bombay, the English commission returned in due time to London and published a report, in which they related observations and conclusions directly opposed to those of the German commission. At the same time they incidentally advanced statements concerning the dejecta of cholera patients which would seem to warrant the inference that they were imbued with a notion, entertained by some medical officers high in authority in India and connected closely with the Government of India, that there is nothing specific or contagious about these dejecta, and that it is extremely doubtful if this disease is at all infectious or contagious, in the ordinary acceptation of those terms.

The German commission recognized the contagious and infectious character of the disease, and, agreeing with many previous investigators, located the infectious principle in the contents of the intestinal canal, and believed it of vast importance, so far as protection against the introduction and spread of cholera is concerned, that this infectious principle should be destroyed at the earliest possible moment.

Serious questions relating to the enforcement of quarantine against cholera, and to the value of other measures of prevention, were immediately raised by this conflict of the English and German commissions.

The report of the English commission, written by a man whose reputation as a pathologist is second to none, printed in the English language, was reprinted extensively in the medical journals and even in the lay press of America; while, on the contrary, the investigations of the German commission, and of those who have more or less confirmed their results, were printed in German, French, or Italian, appeared in English either not at all or only in abstract, and did not have an equal opportunity of reaching the medical profession or the general public interested in the subject in this country. This conflict of opinion, and the full publication of only one side of it in America, concerning a matter of such far-reaching importance to our 60,000,000 inhabitants, seemed to have been a sufficient warrant for the United States Government to send an American commission to Europe and India to investigate, on behalf of our own country, the grounds of these diverging opinions.

From the time that Malgaigne went to Warsaw in 1832 to make acquaintance with an unknown plague in Europe, until Dr. Koch in 1883 visited Egypt and India to investigate the

same disease, many have been the eminent physicians who have left their homes to study cholera in distant regions, and many have been the exhaustive observations of the disease in all its forms and characters which have been made by the most distinguished clinicians and pathologists of the world during the times when it has repeatedly ravaged their own lands. The whole category of symptoms and visible signs by which Asiatic cholera under its various guises manifests its presence had been so often the object of the keenest and most intelligent examination, and so frequently the subject of most learned disquisitions that its prompt and unhesitating recognition might reasonably seem, when it appeared in Europe in 1884 and 1885, to have been a matter of no great difficulty.

But what is the truth? Look at the recent experience of France, and Spain, and Italy. In each the prompt, vigorous, and judicious action required for the extinguishment of the spark before it could burst into an uncontrollable conflagration was paralyzed by doubt and uncertainty concerning the real nature of the disease.

While epidemic cholera was surely planting itself in France in 1884, few physicians asserted its presence with firmness, while the many denied it most positively. To remove the hesitation which this conflict of opinion naturally engendered, Drs. Brouardel and Proust were commissioned by the French Government to report upon the nature of the doubtful disease at Toulon. Those experienced physicians had the knowledge and the courage to unhesitatingly pronounce it epidemic cholera, but unfortunately they were unable to state its origin. On the other hand, Dr. Fauvel, inspector-general of hygiene, placed the weight of his high authority against that opinion and reproached the commissioners with having uselessly alarmed the country and caused great damage to the commerce of France. Later, the national consulting committee of hygiene officially declared that the disease was not Asiatic cholera, but was a benign cholera, non-contagious and produced by local causes, and that it had nothing at all to do with importation from without, and possessed no power of epidemic dissemination. Added to these misleading statements was the impression produced by the majority of the medical press of that country in industriously supporting the assumption that the epidemic would limit itself to the locality of its outbreak, and would soon cease.

As in France, similar doubt and uncertainty and inaction existed in Spain at the commencement of the invasion of cholera in 1885. It is true that a few scattering cases of cholera, mainly confined to some localities in the province of Alicante, had appeared in 1884, but the epidemic which so frightfully ravaged Spain in 1885 undoubtedly spread from the town of Játiva, in the adjoining province of Valencia.

After having lingered in that vicinity through the winter under the mask of *suspicious cases*, during the fourth week in March of that year the epidemic raised its head in this town. Public rumor to that effect, originating with the physicians of Játiva, soon reached the Governor of the province and the city of Valencia; and in response to the demands of the populace a special commissioner was dispatched to investigate. Arrived in Játiva, a few cases examined, and a hasty consultation held with the local board of health, an official declaration was hurriedly published that Asiatic cholera did not exist in that place; and later the provincial board of health confirmed this opinion. Nevertheless the unknown mysterious disease continued to spread throughout the town and, besides, rapidly invaded village after village, unchecked by any active opposition. Notwithstanding, as late as the 15th of April the same provincial board of health formally congratulated the people upon the favorable course and slight importance of the disease, which was even then officially looked upon as *only suspicious*. During this time of inaction and hesitation on the part of the authorities there reigned the greatest anarchy of opinion among the local physicians. A few affirmed their belief that they were dealing with genuine Asiatic cholera; some insisted that the suspicious visitor was nothing more than the common sporadic cholera; others declared it to be a pernicious fever of choleraic type; many claimed that it was malignant malarial fever; yet others held that it was a kind of entero-gastritis; and not a few pretended that it was the bubonic plague, but without the boils. The whole history of the invasion of Egypt in the first place, and of France, Italy, and Spain later, is nothing but a repetition of similar doubts on the part of the physicians having to deal with



the disease, and of inaction on the part of the local authorities whose business it was to adopt and enforce measures to check it.

But why continue longer in narration of this disgraceful and unfortunate history of the doubts and contradictions and vacillations concerning the nature of the disease which have characterized this as well as all former visitations of Europe by epidemic cholera? It forcibly illustrates one most important fact.

That fact is, *unless the investigations of the German commission have brought to light a sure and unmistakable diagnostic sign of Asiatic cholera which can be quickly distinguished*, in spite of the great and valuable knowledge of the disease gained by the study of former epidemics *we do not at present know how to recognize genuine epidemic cholera in time to safely guard the people against its deadly power.*

In Egypt and in France and in Spain and in Italy the character of the disease and the consequent danger were not fully recognized until it was too late to arrest its destructive course, and thus it has been everywhere and at all times in the history of the march of epidemic cholera.

This is the undeniable truth, and acknowledging it let us turn again to the most important outcome of the work of the German commission, namely: the announced discovery of a peculiar micro-organism in the intestinal contents and evacuations of genuine epidemic cholera, as always present in certain stages of this disease, and always absent in all other diseases and in health; and furthermore the claim that this micro-organism (the so-called comma-bacillus of Koch) possesses peculiar characteristics which enable it to be quickly and certainly distinguished from all other micro-organisms; and that, consequently, its presence furnishes a sure and quickly applicable means of accurate diagnosis.

For those who hold that cholera is a disease communicable either directly or indirectly from person to person, and therefore from place to place (and experience has led nearly the entire medical world to this opinion) it would seem to be axiomatic that if this claim for the diagnostic significance of the "comma-bacillus" be established, its practical value must be well-nigh incalculable, because in that case, for the first time in the history of this disease, it will become possible to detect its nature at every point of entrance and every stage of its progress in time to destroy the infectious agent, and thus far more surely prevent the development and dissemination of an epidemic.

What has been already said will indicate the great importance of the discovery of a diagnostic sign of ready application—even if there be nothing more in the discovery of Koch—which will enable physicians and health authorities to recognize to a certainty the presence of Asiatic cholera at the very commencement of an invasion so that prompt and energetic measures necessary to prevent an epidemic may be adopted and rigidly enforced without loss of time.

As to the second portion of the claim of the German commission, that these micro-organisms are not only the constant accompaniments of cholera but are also the active cause of the disease, it may be said that in this also, should their claim be established, a discovery of the greatest practical value for the eradication of cholera, not only in those districts where it may from time to time prevail as an epidemic, but as well also in those where it has an endemic existence (or in other words is constantly present), will have been made.

Though the chief of the English cholera commission has expressed himself very positively as more than doubting the reality of the discovery of the active cause of the disease by the German commission, he has not hesitated to declare an opinion as to the vast practical value that such a discovery must necessarily have. In his last publication concerning the micro-organisms of cholera, the beginning of which appears in the "Practitioner" October, 1886, he uses the following language: "The laws governing the spread of cholera are and have been well understood by sanitarians. The fact that cholera, like other infectious diseases, is a communicable disorder, spreading from a focus of infection, has been long understood." A little further on he says that "there can be no doubt that the identification of a cholera germ, the knowledge, which from such a discovery would inevitably follow, of its nature and mode of spread, of its mode of



alteration by temperature, soil, and season would unquestionably lead to a more specific application of the means to ends than has hitherto been the case. Besides, by an exact knowledge of the cholera germ we would be enabled accurately to determine the mode of invasion of the human body by the cholera virus, the distribution of this latter in the body, the changes it undergoes, the manner in which it leaves the body, and the many other important questions, which would at once emerge from the region of debatable points wherein they at present are; in other words, this knowledge would give us a thorough insight into the whole etiology and pathology of the disease, which at present we do not possess. One important series of effects would by the discovery of the cholera germ at once become plain, namely, the mode of its entrance into the human body and the mode of its exit. At present opinion is divided on both of these most essential questions. How does the cholera virus enter the human body? Does it enter by the alimentary canal only, as is maintained by many authorities, or does it enter also by the respiratory organs? How does it leave the infected body? Is it present in the vomit and discharges from the bowels, as is maintained by most of the observers, or is it present in these not as an actual but as a potential virus, as maintained by other equally great authorities? It is obvious that, according to either one of these theories, the mode of our action in combating the spread of the disease ought to become exact and specific."

In discussing the importance of determining what the State can do to prevent cholera, the recent surgeon-general of India and sanitary commissioner with the Government of India, J. N. Cunningham, M. D., very justly states "that the questions involved are questions of vast interest, not only to the people of India, but to people of all countries. They involve the health and happiness of millions of homes in all parts of the world."

We have only to recall the immense losses which have been suffered by most of the civilized and uncivilized nations of the world through the invasions of this disease to appreciate the great practical value which the solution of these questions may have. In India, where cholera rages constantly from year to year, the sanitary reports of the Indian Government for the last twenty years show that during that period the losses by cholera in that country among the native population have been 249,523 per annum, making a grand total of deaths from cholera in that country during that period of 4,990,460.

In referring to the ravages of epidemics of cholera in Europe it is not necessary to summarize the total losses which have occurred since the first visitation by cholera in 1832, but attention may be called in this connection to the extent of the damage done by the last epidemic. In 1883 Egypt is said to have lost 60,000 lives from cholera, and in 1884 and 1885 Italy and France together have been estimated to have lost in the neighborhood of 60,000 inhabitants from the disease, and to this number should be added the losses which Italy has again suffered during the years 1886 and 1887 from the same cause. The losses of Austria-Hungary have also been considerable. Spain, however, was the greatest sufferer from the ravages of cholera during the epidemic. Among a population of 16,000,000 there were, according to the official records (which are no doubt short of the reality), 338,685 attacks and 119,620 deaths of cholera.

When one undertakes to estimate the mere loss to a country of the intrinsic value of the lives destroyed, the amount, although great, must seem insignificant when compared with the loss of incalculable millions of treasure from the paralysis of industry and commerce. So that when the same surgeon-general of India, above mentioned, in the above-cited book in which he undertakes to discuss this subject *purely from the practical stand-point*, speaks of the theories which are at present entertained or have been entertained at various times by scientific bodies concerning the nature of the disease, and says, "whether these theories are scientifically correct or not is a matter of very minor importance," he can scarcely expect that many familiar with the history of the ravages of cholera in parts of the world outside of Hindustan can agree with him.

Allusion has been made to the intense excitement in the medical world, occasioned by the announcement of the alleged discoveries made by the German commission, in 1883 and 1884, in Egypt and India concerning the cause and nature of cholera. It is true that at the time of the epidemic in Europe of 1873, and even of those as early as 1865, 1866, and 1867, it began to

be appreciated by leading investigators and authorities that cholera is probably due to the agency of a living micro-organism capable of enormous powers of reproduction and propagation, yet the methods of research at those dates were so imperfect and lacked so much of the necessary precision that such opinions were mere matters of conjecture or conclusions deduced from faulty observations, rather than grounded upon well-established facts. But since the last visitation of Europe by cholera in 1873 and 1874, such enormous strides have been made in that department of medical science and research which deals especially with the nature and causes of infectious diseases both of man and animals, and such unprecedented improvements made in the construction and use of instruments of precision, that it may be very justly said that the exact knowledge of the causes of certain epidemic or infectious diseases acquired during the last ten years is both greater and more exact than the whole of that which had accumulated during the last two centuries. When those very men most skilled in the modern and exact methods of research, who by their former successful investigations in the causation of disease had by tacit assent come to be regarded as the leading bacteriologists and experimenters of the world, were commissioned to investigate anew the etiology of Asiatic cholera in 1883, scientific men were prepared to expect far more definite and reliable results from their labors than had been previously acquired, and were already inclined in advance to receive any announcements from them of new discoveries with a much greater measure of credence than had ever before been extended to investigators of cholera.

But notwithstanding the great authority of the German commission, their work was not long allowed to pass unquestioned. The first contradictions came from the official French commission, sent out by their Government to investigate cholera in Egypt as already mentioned. The next serious opposition arose under the authority of the British Government, the adverse report of whose commission has also been alluded to. Adverse criticisms began rapidly to appear in the medical and scientific journals of the world from the pens of skilled and unskilled investigators as well as of those who had never before undertaken original research, and the liveliest contest, both in support of and against the claims of the German commission, took place before all the medical societies of importance. Furthermore, serious observations bearing upon the questions involved began at once to be made in many of the great laboratories of Europe.

The most energetic criticisms appeared in France, England, and India. As already stated, the observations of the French commission in Egypt were not in accord with those of the German commission. This circumstance, and perhaps even national jealousies to some extent also, prompted the forming of adverse opinions in France.

In England the great authority of the chief of the British commission, and the vast financial interest of Great Britain in Indian commerce, at once occasioned a strong popular feeling in the British Isles against the establishment of the doctrine of the contagiousness and transportability of a disease which in the past had always visited Europe after first starting in India.

When the epidemic established itself in Southern France in 1884 the eyes of all Europe were naturally directed to the scene of its ravages with the expectation of obtaining something tangible and positive upon which to support conclusions in a measure already formed. The German commission was again directed to pursue their investigations, this time in Marseilles and Toulon. Investigators more or less skilled and experienced in the modern methods of research went in an official or a private capacity to these cities from England, Belgium, and Spain. The French Government also, as was to be expected, had an official commission at work upon the same ground.

In the midst of the conflicting opinions among the medical men of France concerning the real nature of the epidemic in the southern portion of that country, it was not long before Dr. Koch found present in the victims furnished by the French epidemic the same micro-organism which he had discovered in Egypt and India, and demonstrated it to the satisfaction of many of the scientists there assembled. Among those who were already inclined to accept his discoveries as authentic the doubt concerning the nature of the disease in France was at once



settled, and opinions already more than half formed concerning the diagnostic value and the pathogenic power of the so-called comma-bacillus were also now nearly determined.

Even the members of the French commission who, while in Egypt, firmly denied the existence in the intestines of cholera subjects of any special micro-organism, were obliged to admit, in consequence of the demonstrations of Dr. Koch, that they had been overlooked by them.

After the departure of the German commission observations concerning the relation of this special micro-organism to Asiatic cholera were pursued in Marseilles by a number of investigators, among whom Dr. Nicati and Mr. Rietsch made the most thorough and exhaustive studies. These gentlemen, in the course of their observations, including a large series of inoculation experiments upon various animals, soon satisfied themselves that a disease, having the clinical and anatomical character of cholera, could be experimentally produced in dogs and guinea-pigs. It has already been stated that the German commission, while conducting similar inoculation experiments upon animals in India, had failed to obtain any positive results. Again, Professor van Ermengem, of Brussels, commissioned by the Belgian Government to investigate the cholera in France, after a most thorough investigation, including inoculation experiments upon animals, independently arrived at results which were entirely in accord with those of Dr. Nicati and Mr. Rietsch. At the same time Mr. W. Watson-Cheyne, of London, after making an experimental study of the question, also arrived at conclusions in the main confirmatory of Drs. Koch, van Ermengem, and Nicati.

On the other hand, the French commission, from their subsequent studies of cholera in France, while they admitted the frequent presence in cholera of the micro-organisms discovered by Koch, affirmed that they are to be met with in other diseases than cholera, and even in some instances during perfect health, as well as in the water of many of the rivers and small streams of France which could not by any possibility have been contaminated by the discharges of cholera patients, and declared, therefore, that the comma-bacillus of Koch could not be regarded as even possessed of a diagnostic value.

The next important communication of a scientific character reporting results of investigations bearing upon the microbes of cholera was made by Professor Finkler and Dr. Prior, of Bonn, in which they announced the discovery of micro-organisms (which they considered to be identical both morphologically, biologically, and pathologically with those discovered by the German commission) in the intestinal discharges of cholera nostras, or of the ordinary cholera morbus of Europe.

When the cholera reached Naples and became epidemic there in 1884, Dr. von Emmerich, representing the Bavarian Government, went to that city for the purpose of making observations concerning the truth of the claims of the German commission with respect to the diagnosis and etiology of cholera. While this scientist confirmed the observations of Koch as to the association of the comma-bacillus with Asiatic cholera, he claimed to have discovered an entirely new and different organism which, after experimental study upon his return to Munich, he claimed to be the real cause of the disease, regarding the Koch comma-bacillus as only an accidental associate of it.

When cholera reached the city of Genoa, Prof. Antonio Ceci, connected with the university of that city, was commissioned by that municipality to make a scientific study of the disease from the stand-point of the latest observations. In the early part of this study he had associated with him his former master, Professor Klebs, of Zurich. The first results of their joint investigations seemed to be somewhat in conflict with those of the German commission and their followers. In the first announcement of these results made by Professors Klebs and Ceci, while the presence ordinarily in cholera Asiatica of the comma-bacillus of Koch was admitted, they affirmed that an identical micro-organism is to be found in many other quite different diseases. But further and more thorough examination and more extended experimental research convinced both of these investigators of the error of their first conclusions, and entirely converted them to the views of the German commission.



The next important communication bearing upon the relations of Koch's comma-bacillus to Asiatic cholera came from Spain in the person of Dr. Jaime Ferrán, who, at the outbreak of the epidemic at Marseilles and Toulon in 1884, had been commissioned by the municipality of Barcelona to proceed to those cities and make an investigation of the cholera there. In this communication Dr. Ferrán not only confirmed the statements of the German commission, but announced other and more advanced conclusions.

These advanced conclusions were of a twofold character :

First, respecting the morphological characters of the comma-bacillus, he claimed that the observations of Koch had not uncovered the whole cycle of existence through which the comma-bacillus passes in its various phases, affirming that, while Koch had observed only two phases of development of the comma-bacillus, he himself had succeeded in following the micro-organisms through several other phases up to that time unknown.

Second, that these micro-organisms are to be regarded not only as the active cause of the disease, inasmuch as genuine cholera can be produced experimentally in various lower animals, principally the guinea-pig, by the subcutaneous inoculation of cultures of the bacillus, but that those animals which survive the inoculations enjoy an immunity against subsequent efforts to produce the disease in them. In other words, that these inoculations possess a certain power of protection against subsequent attacks.

This, in brief, had been the history of the recent scientific investigations concerning the diagnosis and cause of cholera up to the time when the American Government deemed it advisable to send their own commissioner to Europe and India for the purpose of arriving, if possible, at definite opinions concerning the various conflicting announcements made since 1883.

## CHAPTER I.

### COURSE OF THE LAST WIDE-SPREAD EPIDEMIC OF ASIATIC CHOLERA

Although cholera appeared among the Mohammedan pilgrims on their way to Mecca by sea from Bombay to Hedjaz, the principal Red Sea port of the former city, in the years 1881, 1882, and 1883 (as will be seen by abstracts introduced later from the report to the German Government concerning investigations relating to cholera in Egypt and India in 1883, prepared by Dr. Georg Gaffky, a member of the commission appointed by the German Government for that purpose), the first epidemic outbreak of the disease appeared in Lower Egypt early in the summer of 1883. It may not be irrelevant to call attention here—especially in view of the disputes concerning the existence of cholera in Egypt earlier than this date—to the fact that in the British army of occupation in Egypt in 1882 there was a brigade of Indian troops and that the base of operations by the land forces was Ismailia, a point in the Suez Canal, which latter had been seized by the British Government from end to end as a strategic necessity.

By reference to an abstract of the official report for the year 1883 of Mr. Hewlitt, the sanitary commissioner for the Presidency of Bombay, hereafter incorporated, it is proven that cholera was epidemic both in the city and Presidency of Bombay during the year 1883, and also existed there to a lesser extent in the course of the two previous years.

The history of the invasions of Europe by epidemics of cholera has shown that these visitations have *without exception* been traced back to India as their point of origin, and that they have followed the course of trade, of travelers or of armies moving either by land or by sea. The last wide-spread epidemic of cholera furnishes no exception to this apparently universal rule concerning its movements.

After devastating Lower Egypt in 1883, cholera made its appearance upon the northern coast of the Mediterranean, first in the maritime city of Toulon, in France, in the summer of 1884. Concerning the origin of cholera in France at that time there has always been some dispute, and the question is not definitely settled even at the present time. Various authorities have attributed it to the return of French troops by sea from the war in Tonquin; others have expressed their firm belief that the seeds of the scourge came directly from Lower Egypt, and in this connection reference may be made to an abstract of a report to the Department of State made by the United States consul at Marseilles, appearing later, in which strong reasons are set forth in support of a statement that cholera existed in the latter city during the year 1883, imported directly from Egypt, although the municipal authorities then and for a long time thereafter assiduously and successfully concealed its presence.

From the port of Toulon cholera spread widely throughout the department of Bouches du Rhône and through several adjacent departments to the east and west in the year 1884, committing great ravages. The disease lingered in France until near the end of that year, re-appeared in a few localities in the south of France in 1885, and in the latter part of that or of the following year visited several places in the department of Finistère in the north-western portion of the French Republic. During the presence of the disease in epidemic form in the portions of France already mentioned the malady made its appearance by more or less scattering cases in the interior of that country. Among other cities Paris afforded a considerable number of victims.

In August, 1884, the disease was carried from Toulon to Spezia in the province of Genoa, the principal naval station in the northern portion of Italy, through the transportation by

sea, at the expense of the Spanish Government, of large numbers of Italian workmen usually employed in Toulon and Marseilles, but thrown out of employment by the paralysis of trade due to the presence of the epidemic.

Besides this exodus of Italian workmen from the above-mentioned French cities by sea, great numbers of these people found their way into the province of Genoa by the land routes. In the latter part of August a few isolated cases of cholera appeared in and around the city of Genoa, in Italy, invariably among people who had found their way into that city from the infected districts of France. The preventive measures of that municipality were so well conceived and executed that the infection was not allowed to spread from these cases. In the month of September, however, the disease suddenly appeared in epidemic form in the city of Genoa, and the origin of this epidemic also was traced to introduction of the germs of the disease by Italian laborers returned from France.

In the month of September, 1884, Cholera also broke out in a virulent epidemic form in the city of Naples, in Italy, and, as in the case of Spezia, the origin of the scourge was likewise traced to Italian laborers returned from Toulon and Marseilles by sea. The disease spread somewhat from these three cities among the neighboring towns and population during this year.

In 1885 cholera was again prevalent in many different cities and towns of Italy; it became widely epidemic in the Island of Sicily, and the city of Palermo, one of its principal ports, suffered greatly, although it had entirely escaped during the previous year, notwithstanding its close maritime and commercial relations with the city of Naples. Towards the end of this year the disease appeared in the city of Venice and some of the neighboring towns on the Italian main, and lingered there through the following winter.

In 1886 cholera prevailed to some extent in Italy, mainly in the northern part and along the Adriatic coast. It was also present in several localities of the Island of Sardinia at this time. It again became epidemic in the southern part of the kingdom, including the Island of Sicily, during 1887, at the end of which year it finally disappeared.

During the autumn of 1884 the kingdom of Spain was invaded by cholera, but it did not become wide-spread there during that year, for it was limited to a few localities in the Mediterranean province of Alicante. The disease appeared to have been introduced here by refugees from Southern France, who, to avoid the rigors of the quarantine which was established by Spain against all places where cholera existed, went first to the northern coast of Africa and thence reached Spain by small sailing boats, and, with themselves, smuggled into the latter country their personal effects. Although the cholera apparently died out in the province of Alicante in the latter part of 1884, the disease seems to have lingered in a few scattering suspicious cases occurring from time to time, although not then recognized as such, in the southeastern portion of the adjoining province of Valencia.

In the months of April and May of 1885, the disease became epidemic in the town of Játiva, in the southern part of this province, and although strenuous efforts were made to stamp it out by sanitary cordons, land quarantines and other rigorous measures, it obtained a firm foothold, and during the later months spread rapidly and very extensively throughout the eastern provinces of Spain, besides reaching in its course many of the provinces in the interior and southern part of that kingdom, committing frightful ravages in many cities. The disease gradually disappeared from Spain toward the end of the year 1885, but it lingered in several places, mainly in the southwest, until the commencement of winter. In the month of December the dreaded Asiatic guest raised its head in the city of Algeciras, on the western shore of the Bay of Gibraltar, opposite that fortress, 6 miles distant. In January the disease broke out in epidemic form on the northern shore of the Straits of Gibraltar, in the ancient city of Tarifa, about 24 miles west of Algeciras, and it spread slightly to numerous villages in the neighborhood of these two cities, besides appearing in the town of Marebella, located on the coast of the Mediterranean, some 30 miles east of Gibraltar. The latter fortress, although it was not visited by the disease in an epidemic form, experienced numerous isolated attacks, mainly among workmen from the neighboring town of La Linea, which had been visited by the epidemic, and among others in frequent communication with the latter village.



In the early part of the spring of this year (1886) cholera finally disappeared from the kingdom of Spain.

Whilst cholera prevailed in Spain, the adjoining kingdom of Portugal escaped the disease, and the immunity of that people is attributed by their sanitarians to the enforcement of a rigorous land and maritime quarantine.

During the year 1884 a few isolated cases of cholera made their appearance at Cardiff in Wales, on board ships from Marseilles, but the disease did not spread. In the following year it again appeared there in a similar manner.

In the autumn of 1886 cholera appeared in the form of a small localized epidemic, which was promptly exterminated by the action of the German health officers, in the neighborhood of the city of Mayence, on the Rhine.

In the summer of 1886 the disease showed itself in Trieste, the chief Adriatic port of the Austrian Empire, where it became epidemic and spread to numerous neighboring towns. This epidemic has been almost universally attributed to importation from the city of Venice and the neighboring Italian towns, where the disease at that time prevailed. In the fall of the same year it broke out at Buda-Pesth, the Hungarian capital, and afterwards became more or less epidemic in several portions of the Austrian Empire, chiefly in Hungary.

All other European countries escaped the visitation of the disease, and it did not extend along the northern and eastern coast of the Mediterranean, comprised between the Adriatic and the Suez Canal; neither did it break out in virulent epidemic form on the northern coast of Africa west of Egypt; the empire of Morocco, so close geographically and commercially to the kingdom of Spain, almost entirely escaped.

The disease was introduced into Buenos Ayres the capital of the Argentine Republic in the month of November, 1886, by means of passengers from the port of Genoa, in Italy, at which time cholera was there present. It rapidly spread from the former city into the interior of the South American republic, and, surmounting the Andes, attacked for the first time the population of Chili, where it became firmly rooted and widely extended, claiming numerous victims during the following year.

In December of 1886 the South American city of Montevideo was visited, the disease here also being imported by travelers from Italy.

In the autumn of 1887 cholera made its appearance in the port of New York upon several French steamers which sailed from the port of Marseilles, but took numerous emigrants aboard in the port of Naples, where cholera at that time existed. Owing to the prompt and efficient measures of isolation enforced at the New York quarantine station the disease fortunately did not extend beyond that point.

In 1885 the cholera was ravaging various places on the eastern coast of Asia, and during this year the empire of Japan especially suffered greatly from its inroads. In these cases also there is strong reason to believe that the germs of the epidemics also were brought from India.

In 1886 we hear of this plague again in Japan, and it was also reported as present in epidemic form in the city of Brisbane, Queensland.

In 1887 the scourge was again ravaging various portions of the Pacific coast of Asia, and it was especially destructive in Corea.

Dr. Mahé, of Constantinople, communicated to the "Revue médico-pharmaceutique," January 21, 1888, the following account of the invasion of Europe by cholera, which, because of its excellence and for the general information which it contains, I deem worthy of introduction here *in extenso* as follows:

#### CHOLERA IN EUROPE FROM 1884 TO 1887.

The last epidemic of cholera in Europe persisted from 1865 to 1874, about ten years. Since this last date up to 1884 Europe enjoyed a complete immunity from cholera for a period also ten years in duration.

But in 1883 the scourge of the East Indies made its appearance in Egypt, where in three or four months it occasioned a mortality of 30,000 to 50,000 of the inhabitants.

On the 13th or 14th of June, 1884, it invaded the French military post of Toulon, probably imported by transport Government ships returning from Tonquin and from Cochin China, where cholera then existed, for it is not admissible in the present state of our knowledge concerning this disease that the cholera in Toulon was due to a revivification of germs which had been slumbering for a dozen years or more in France.

The epidemic invaded successively, and after short delay, Toulon and Marseilles, whence it spread through several departments of the south and southeast of France. Then a little later it spread further toward the department of the Seine-Inférieure (Yvetot and Fécamp upon the Manche), that of the Loire-Inférieure (Nantes) and as far as the Vendée (Île de Noirmoutiers), when the cholera disappeared about the 10th of January, 1885.

In 1885 the re-appearance of cholera at Marseilles about the end of the spring was apparently only a recurrence of that of the preceding year. In 1885 and 1886 Bretagne and principally Finistère were the theaters of a small cholera epidemic, fortunately limited. Such was in France the last manifestation of the Indian scourge, which cost the lives of about 13,000 to 15,000 inhabitants.

In Algeria cholera appeared, imported from France, in the lazarettos of Bône and Philippeville, near Algiers, among soldiers coming from France, and in Oran, during September, 1884, where it committed some slight ravages in the province of that name. There was a slight recurrence in 1885 in Algeria, and also in Tunis, where the disease was again imported from France and Spain.

In Spain the commencement of cholera occurred about the month of August, 1884, at Alicante and along the banks of the Vinalpsa, very probably through importation from Marseilles or from ports of the south of France. During the winter of 1884 and 1885, instead of entirely disappearing, the cholera continued as sporadic cases, and it resumed its activity in the first days of 1885 at Guadarrama, near Alicante, in the province of Valencia, where it lingered for two months, and then spread suddenly at the end of the spring, invading almost the whole of Spain.

In that country, as usual, the epidemic followed in its general diffusion the frequented routes of communication, spreading from provinces attacked in succession by reason of their proximity, to those which were distant. In a few months the Iberian Peninsula (except Portugal, which escaped) paid an enormous tribute in the death of 150,000 to 200,000 inhabitants.

In Italy cholera appeared in 1884, brought into that kingdom by Italian emigrants from the south of France, or rather by returning Italian subjects already attacked with the disease, which they propagated from the west to the east and to the south of the Italian peninsula.

During the first month of the spring of 1885, after a cessation of the disease, probably incomplete, cholera appeared again in Italy, at first lightly, afterwards in a virulent epidemic form. It may be said that this was a recrudescence, but it is possible that this second epidemic was also the result of an importation from France, where the disease had recurred, to a slight extent it is true. In September cholera appeared in Sicily, at Palermo, where it made great ravages, and where it was imported from France or Italy.

In 1885 cholera persisted at Venice, where it occurred in isolated cases during the whole of the winter of 1885-'86.

In April it appeared at Brindisi and its neighborhood, and during the whole of the rest of the year 1886 it again ravaged the peninsula more violently than in the preceding years, especially the districts of the east and the south upon the coast of the Adriatic, and especially at Venice, which became a very active focus of the epidemic.

From Venice the cholera was transported a first time to Trieste in 1886, and again also, towards the end of 1886, to the Austro-Hungarian shores of the Adriatic. The epidemic of Trieste spread to Istria, to the Hungarian banks of the Danube and to Hungary, principally in its southern provinces. There were also some slight invasions by cholera, but without many ravages, of Servia and the province of Bosnia. But the whole of this epidemic ceased at the end of the year 1886, or at the beginning of 1887, since when Austria-Hungary has remained absolutely free from cholera, which cost the empire only 2,000 to 4,000 inhabitants.



It was not the same case in Italy, which for the fourth time experienced the re-appearance of cholera towards the month of June or July, 1887, at first in Sicily, in Catania, then in the province of that name, in that of Palermo, in that of Messina, the capital of which had been recently the focus of a violent epidemic. A little afterward cholera was imported from Sicily to the Italian continent, notably to the environs of Naples and of Rome, and it was introduced into Malta.

Although slight in comparison to previous visitations, save at Catania and especially at Messina, this last epidemic caused a mortality of about 5,000 inhabitants in Sicily, of some hundreds upon the continent, and of 500 to 600 at Malta, where it at present is committing slight ravages.

In brief, the kingdom of Italy, including the islands of Sicily and Sardinia, has lost in four successive years from the visitation of cholera about 40,000 to 50,000 inhabitants—a heavy tribute of human lives, aggravated by commercial losses occasioned by the continuance of restrictive measures imposed by foreign Governments upon the maritime trade of that country.

#### RÉSUMÉ.

The last epidemic of cholera in Europe has cost France 15,000 inhabitants in 1884, 1885, and 1886; Spain, 180,000 inhabitants in 1884 and 1885; Austro-Hungary, 4,000 inhabitants in 1886; Italy, about 50,000 inhabitants in 1884, 1885, 1886, and 1887; Malta, 500 inhabitants in 1887: a sum total, approximately, of 250,000 inhabitants of Europe.

In other words, the epidemic has removed from France about one inhabitant for every 3,000, from Italy one inhabitant for 550 or 600, from Spain one inhabitant for every 100, from Austro-Hungary one inhabitant for every 9,000.

An approximate calculation of these losses estimated from the purely material point of view shows a sum total of about 400,000,000 francs of value destroyed. A still greater loss resulting from the damages caused by the disease, through idleness, interference with commerce and navigation, interruption of business, etc., would increase the sum total of the losses occasioned by the cholera to about a billion of francs in three to four years. These figures based upon the actual estimation of the material value of human life are so forcible that nothing needs to be added.

Whilst the cholera from 1884 to 1885 did not traverse the whole of Europe, as was feared at the beginning, it has none the less continued up to the present time to re-appear each year; and we have no assurance that it has reached its termination. But is it indeed the same cholera which began at Toulon in the month of June, 1884, and has just ceased during the last months of 1887, at least for the moment, in Sicily and Malta?

Certainly, yes. We can follow it exactly in France from Toulon to Marseilles; from the south to the north, and to the northwest; from the coasts of the Mediterranean to those of the ocean and to the Manche; from the mouths of the Rhône to those of the Loire, of the Seine, and even to the extreme point of Finistère. It is indeed the same cholera which has ravaged Spain from the Pyrenees to Andalusia; which has passed across the Mediterranean into Algeria; which has crossed the Alps, the Apennines, the Adriatic; which has reached the banks of the Danube, the Tisza, the Maros as far as the bases of the Transylvanian and Carpathian Mountains, and which has extended slightly even to the foot of the Balkans and the mountains of Bosnia; which has in a word desolated the great cities of Marseilles, Toulon, Toledo, Malta, Granada, Venice, Naples, Palermo, Trieste, Catania, and Messina, to make no mention of the innumerable villages and hamlets which it has sometimes decimated and sometimes reduced by a third or a half of their inhabitants.

However irregular this peregrination may be, one can, however, easily follow its principal traces, for the leading thread of the plague, although at times obscure or invisible, has never been up to the present time absolutely broken. If its continuity appears sometimes to be lost in our investigations, it will be refound by a more profound search.

For the transmission from the south to the rest of France; from France into Spain and into Italy; and from Italy into Austro-Hungary, etc., the facts are decisive. Some doubts have



been raised concerning Italy, where it was believed a new importation occurred—for example, at Brindisi in 1886, and recently at Messina in 1887; but the assertions advanced as proof that these were new importations reposed upon no positive facts, whilst the relation between the four successive recrudescences in the Italian peninsula and in Sicily is precisely established.

I have elsewhere shown (for example “*Gazette médicale d'Orient*,” 1886), that the epidemic of 1886 was the successor of that of 1885, and that in Venice the cholera, far from being extinguished, persisted throughout the winter in a sporadic form in order to give rise to an active recrudescence in the spring and in the summer of 1886.

In the year 1887 it was the same in Sicily, where cholera appeared in some places toward the end of that year. In 1887 it was reported that the cholera in Catania also was sporadic, and the authorities of that city declared that it originated from the well-known bad hygienic condition of that place.

It was only at the end of June, or rather at the end of July that, overcome by incontestable evidence, they determined to officially declare the presence of cholera at Catania, where it had existed for a long time. This was also the case in 1884 and 1885 in Spain, where cholera persisted sporadically throughout the winter, in the province of Valencia.

I deem it useless to multiply these examples, which are so numerous and which constitute a mass of facts—“a forest of facts,” as the great Bacon said—and afford incontestable evidence.

Furthermore, a certain number of other facts show the tendency of the cholera to extend from Italy even across the Atlantic. These are at least three in number.

The first is that of the steamer *Matteo Bruzzo*, of which I have given the details in the above-mentioned communication upon the European cholera of 1886, details which I borrowed from the report of Italian cholera in 1884 and 1885. This ship, carrying 200 emigrants destined for Montevideo, departed from Genoa in September, 1884, was turned back from Montevideo, and fifty-four days after the departure from Genoa experienced an outbreak of cholera, which attacked 40 persons, of whom 19 succumbed.

Whilst, thanks to the exclusion of this steamer, cholera was not this time imported into Montevideo, it was carried later to La Plata by another Italian ship, also transporting passengers from the Italian Peninsula. This plague extensively spread through South America for several months, and even threatened to come back across again the ocean from Montevideo, at the commencement of the year 1887, upon a returning French packet.

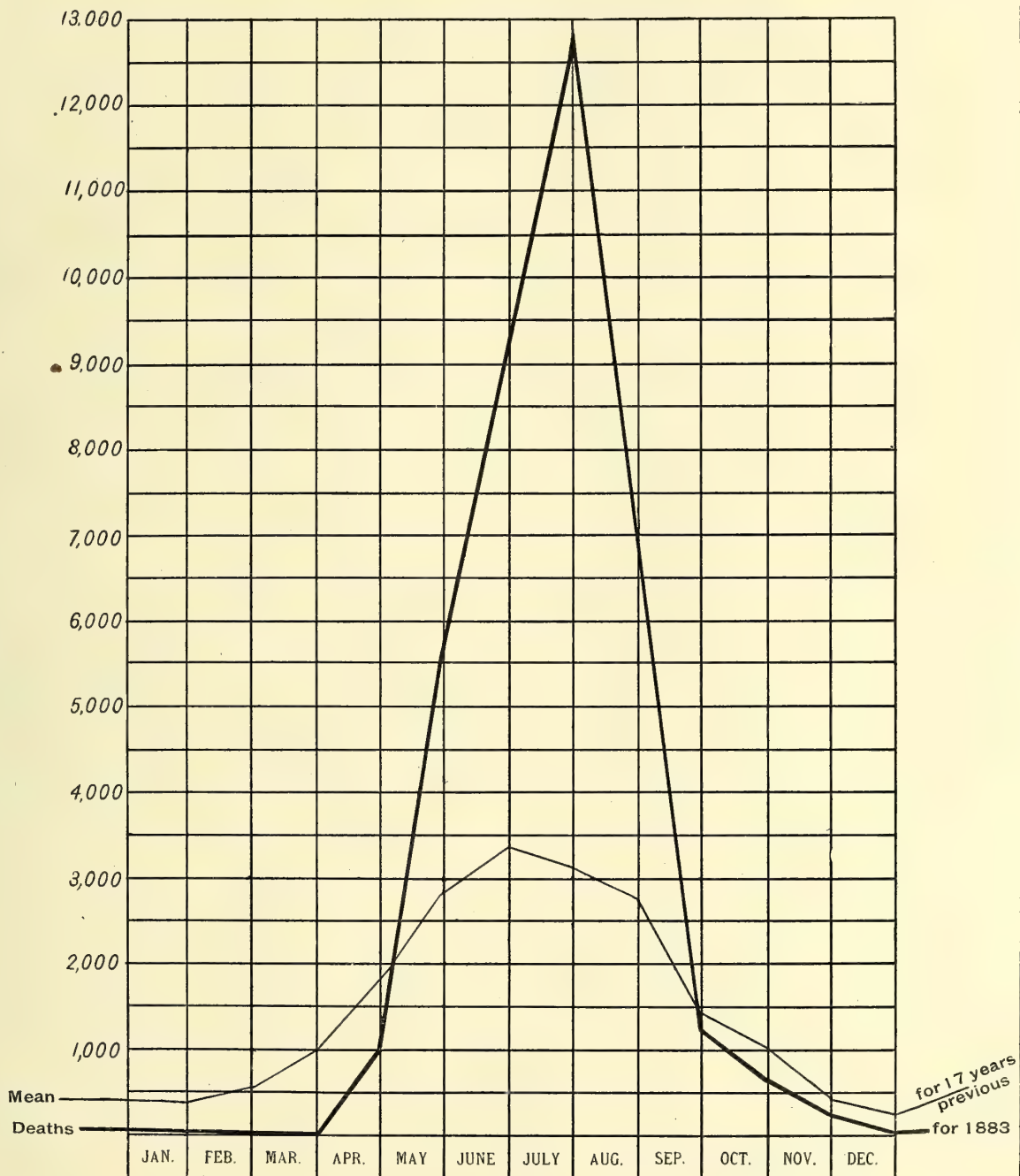
In the third case, toward the end of the same year, two ships (the *Alesia* and the *Britannia*) having at Naples taken aboard passengers destined for New York, transported cholera as far as the harbor and the lazaretto of that city. Fortunately the very rigorous and prolonged measures which were enforced upon the passengers, who were debarked and isolated first at Hoffman Island and then upon a floating lazaretto, succeeded in preventing the disease from reaching to this great city of the United States. These events took place in October and November, 1887. On this occasion the municipality of New York demanded the repulsion of these ships, or at least an interdiction of the admission of immigrants coming from infected countries.

I have added these convincing examples to the preceding to illustrate the transmission, at long distances, across vast maritime wastes, and after long voyages, of a disease so contagious as is cholera asiatica.

So that, since its beginning, the cholera of 1884 to 1887, probably originating in the extreme East, does not seem to have sensibly lost its power of transmissibility, notwithstanding its somewhat insidious course and its relatively benign appearance upon the continent of Europe.

After this foregoing rapid and cursory review of the movements of cholera beyond the bounds of India during the last epidemic, more particular attention will now be given to some details of its course in the various countries mentioned, as they incidentally appear in accounts of the hygienic condition and living-customs of the populations affected. Before entering upon these, attention is desired to be called in advance to the salient fact that the spread of cholera, after its introduction in a locality, is universally associated with contaminated water supply, filthy habits, and bad personal and domestic hygiene.

DIAGRAM  
SHOWING THE MONTHLY MORTALITY FROM CHOLERA IN THE BOMBAY PRESIDENCY FOR 1883, AND THE MEAN FOR THE PREVIOUS 17 YEARS.



(From Report of Sanitary Commissioner of Bombay Presidency, for 1883.)





In speaking of matters relating to demography, we deem it preferable, whenever possible, to allow the local sanitarians, through their official and scientific publications upon the subject, to speak for themselves, for they, at least, can not justly be charged with a biased judgment against their own habits of life and sanitary surroundings—circumstances which sometimes unavoidably influence the opinions of foreigners accustomed to different social conditions. Facts and reflections concerning the etiology, prophylaxis, and cure of Asiatic cholera will from time to time appear in the following section in a more or less disconnected manner. They will prepare the way for a more consequential discussion of these subjects at a later time.

## SECTION 1.

### HISTORY OF THE INTRODUCTION AND SPREAD OF CHOLERA IN EGYPT IN 1883.

#### CHOLERA IN BOMBAY PRESIDENCY FROM 1866 TO 1883.

T. G. Hewlett, deputy surgeon-general and sanitary commissioner for the Presidency of Bombay, in his official report for 1883, speaks as follows concerning cholera in Bombay :

During 1883 cholera caused 37,954 deaths throughout the presidency. The deaths from cholera in each of the eighteen years ending 1883 were as follows :

1866.....	23,027	1872.....	15,642	1878.....	46,743
1867.....	5,143	1873.....	283	1879.....	6,937
1868.....	6,347	1874.....	37	1880.....	684
1869.....	52,330	1875.....	47,555	1881.....	16,694
1870.....	2,666	1876.....	32,117	1882.....	7,904
1871.....	5,821	1877.....	57,252	1883.....	37,954

So that the number of cholera deaths in 1883 exceeded the decennial mean by 16,333, and those in 1882 by 30,050, and was only exceeded in 1869 when 52,330 deaths were registered ; in 1875 when 47,555 were recorded, and in 1877 and 1878 when the deaths ascribed to cholera amounted to 57,252 and 46,743, respectively.

The accompanying diagram, which was borrowed from this report, shows the monthly mortality from cholera in 1883 as compared with the mean for the previous seventeen years.

#### THE CHOLERA EPIDEMIC OF ADEN AND OF HEDJAZ IN 1881.\*

In 1881 the great feast of "Kurban Bairam" fell between the 2d and 4th of November, but there were already on the 16th of September not less than 13,000 pilgrims present in Mecca, and up to the 28th of September this number had risen in Jeddah alone to some 16,000.

Among those ships which early touched at Jeddah was the steamer *Columbian* with a cargo of rice and 650 pilgrims on board. It had in July left Bombay, where at that time cholera was quite prevalent (118 fatal cases in July), and had debarked its pilgrims in Jeddah on the 10th of August.

Now the *Columbian* not only carried with her on this voyage the cholera from Bombay to Aden, but she also rests under the not ungrounded suspicion of having introduced the germ of the disease into Jeddah, and of having been the cause of the epidemic which broke out there in September. It is, therefore, important to examine somewhat closely the course of cholera in Aden.

Upon her arrival in Aden the ship had received free pratique after a simple inspection, for the state of health of the pilgrims was good, and the seven deaths which had occurred during

\* Report of the German Commission concerning cholera. Gaffky. Arbeiten aus dem kaiserlichen Gesundheitsamte. Bd. III. 1887. Compare Mahé: "Mémoire sur la Marche et l'Extension du Choléra Asiatique des Indes-Orientales vers l'Occident, etc. Constantinople, 1885," etc.

the voyage were regarded as unsuspicious. Four of these had taken place among the pilgrims and were by the captain returned as due to *senile debility* and *exhaustion*, whilst the two others occurred among the crew. One of the two latter cases affords especial interest as it had to do with a stoker who eleven days after the departure from Bombay, on the 29th of July, died of an attack of *colic*.

In Aden the unloading of rice was at once begun. On the 2d of August, the second day after the arrival of the ship, it is stated, one of the coolies employed in unloading suddenly died with symptoms suggestive of cholera. The investigation immediately ordered showed that two other coolies similarly employed were sick with the same symptoms, and prompted a second inspection of the *Columbian*, which, however, did not reveal any suspicious cases among the pilgrims or the crew. Soon after that two more of the coolies employed at the ship became ill. In consequence thereof the suspicious guest had to undergo a three-day quarantine of observation in the outer harbor, and fumigation of the ship's hold was ordered. At the end of three days the captain was granted a clean bill of health and a clearance for Jeddah, for even yet the health of the pilgrims and crew had experienced no loss. Meantime, on the 3d of August three other coolies, as well as a Somali woman, who lived in the bazaar of Steamer Point, in a tenement house situated on the harbor, became ill with the same symptoms. Thus up to that day the number of cases had already increased to 10, and 6 of them had ended fatally.

In the next eight days, neither on Steamer Point nor in the neighboring Arab and Somali village of Maala were there any further attacks. It was only after the 14th of August and onward that the epidemic developed in an unequivocal manner, principally among the inhabitants of Maala, where, besides others also, the majority of the 50 coolies employed on the *Columbian* lived under unfavorable hygienic conditions. This village lies upon the road leading from the harbor to Aden. Among the inhabitants of the city itself, which is several kilometers distant from the harbor, the first known case of the disease occurred on the 28th of August. Up to the 27th of September there was a total of 28 attacks and 24 deaths in the city.

On that day the disease appeared to be arrested, but from time to time a case still occurred, viz, on the 15th, 20th, 25th, and 30th of October, two of them being within the city.

In a population of 30,000 the known attacks reached 187, of which 151 were fatal, and there is no doubt that similar cases often escaped observation. Noteworthy is the small tribute of the city itself (24 out of 151 fatal cases), as well as the circumstance that among the European colony only a single case occurred, that of a soldier's wife, who lived on Steamer Point, and who had for a long time suffered from diarrhea, whilst of the Europeans living in the city itself not one was attacked.

The 187 attacks are divided as follows :

Somalis .....	135
Other Africans .....	9
Arabs .....	27
Kadisers .....	9
Europeans.....	1
Total.....	187

Some localities, situated somewhat further in the interior, and which had intercourse with the city, probably became infected from Aden. The disease was probably introduced thence into Makallah and two other small harbors on the south Arabian coast, where attacks occurred about the middle of November, but exact information concerning this matter is not forthcoming.

The Egyptian "conseil sanitaire maritime et quarantenaire," cognizant of the occurrences in Aden for the first time at the beginning of September, after the *Columbian* had unloaded her pilgrims in Jeddah already some weeks before, no reason for subjecting the pilgrims to quarantine was found by the port officials: for a clean bill of health given to the ship in Aden was exhibited; and according to the declaration of the captain no suspicious cases of disease occurred on the voyage from Aden to Jeddah; and moreover the inspection showed nothing



suspicious. Of the state of affairs at Aden the port officials at Jeddah received their first information later.

It is worthy of remark, as mentioned by Dr. Mahé, that at the debarkation at Jeddah there were 660 pilgrims, whilst their number according to the ship's papers shown in Aden was only 650. About the middle of August all the pilgrims of the *Columbian* had already left Jeddah for Mecca. It may be mentioned in this connection that on the return voyage to Bombay no case of cholera is reported to have occurred among the crew.

On the 26th of September, the "conseil" received information from Suakin, dated the 20th, that the cholera had broken out among the pilgrims at Mecca. Later news, however, showed that the physician of the hospital in Mecca had already, from the 29th of August to the 16th of September, observed 14 fatal cases with symptoms suggestive of cholera. On the 18th of September three soldiers ill with similar symptoms, of which one died after twenty-four hours, came under the care of another physician. From the 16th to the 21st of September the number of fatal cases reached 54 according to the official returns, so that there could be no longer any doubt as to the character of the disease. Moreover, Dr. Chaffey Bey, sent by the "conseil" to Mecca, declared positively that they had to do with cholera.

Furthermore, it may be pertinent to add that the *Columbian*, in the space of six months during the year 1881 made no less than five trips between Bombay and Jeddah, and transported to the latter a total of 3,566 pilgrims.

The following table, the data for which Dr. Mahé drew from the archives of the Turkish sanitary administration, shows clearly the direct and rapid intercourse by the steamer between Bombay and Hedjaz during the year in question :

*Voyages of the English ship Columbian, 1,417 tons, Capt.  
G. Baldwin, between Bombay and Jeddah, in 1881.*

Date of delivery of bill of health in Bombay.	Date of arrival in Jeddah.	Number of pilgrims landed in Jeddah.
Apr. 20, 1881.....	May 4, 1881.....	477
June 2, 1881.....	June 19, 1881.....	279
July 16, 1881.....	Aug. 9, 1881.....	660
Aug. 29, 1881.....	Sept. 13, 1881.....	1,060
Oct. 8, 1881.....	Oct. 20, 1881.....	1,090

The number of pilgrims congregated at Mecca during the feast of "Kurban Bairam" was upwards of 60,000, of whom 37,785 had been landed at Jeddah. On the 15th of November the "conseil" received from its delegate, Dr. Chaffey Bey, a report which contained the following language :

"The feast of Mouna took place under deplorable sanitary conditions. The third and fourth days of the feast will remain for a long time in the memories of more than 60,000 pilgrims. Notwithstanding the figures given officially in our dispatches, the number of deaths, and especially of attacks, during those two days has been incalculable; after the dispatch was sent the mortality rose on the 6th of November to 300 per day."

The total number of victims to cholera in 1881 among the pilgrims congregated in Hedjaz, according to the official figures (Stékouli : *Le Pèlerinage de la Mecque et le Choléra en Hedjaz*. Constantinople, 1883) was 4,561, but one will scarcely err if with Dr. Mahé one estimates them at 6,000 to 7,000, which would give, exclusive of the deaths due to other causes, 10 per cent. as lost by the plague.

Whilst the cholera in Hedjaz was slaughtering its victims certain quarantine establishments were, with wise forethought, put in condition. The necessary sanitary and military personnel, water-tanks, water-skins, medicine, disinfectants, hospital beds, etc., were forwarded free of charge, with provisions and attendants in addition to what might be supplied in the locality. At the instigation of Dr. Schiess Bey in Alexandria an aid committee was



established throughout Egypt for the collection of money, food, and clothing for the needy pilgrims. Their own steamer preserved direct communication between the establishment and Suez.

The sanitary personnel in El Wedj consisted of five physicians and three pharmacutists. Toward the end of November, besides these, the inspector-general of the sanitary service, Dr. Ardonin, was present in order to personally supervise the sanitary service.

On the 27th of November the first ship, *Mula*, with 560 pilgrims on board, from Jeddah came into El Wedj; on the 28th followed the *Kaisseri*, with 957, and the *Babel*, with 829 pilgrims, and on the 4th of December there were already 3,358 pilgrims collected at this place.

On November 28 there were 2 deaths from suspicious diarrrhea, but it was not until the 1st of December that the first death from cholera was recorded. Up to the 7th of December there were 21 deaths from cholera and 12 from suspicious diarrrhea, whilst there were also 12 from other causes, making a total of 45 deaths during that period.

The cases of cholera occurred in all of the divisions, but that from the ship *Babel* was most affected. The disease also broke out suddenly and with great severity among the crew of this ship whilst she still lay in the harbor of El Wedj. On the 5th of December nine strong, young sailors, up to that time healthy, were attacked at the same time; 3 of them died in the course of the same day, 2 on the 6th, and 1 on the 7th of December. Landing of the crew and disinfection seem to have arrested this ship's epidemic.

From the 8th to the 15th of December there were in El Wedj station 45 more fatal cases, of which 32 were classified as from cholera, and 7 from cholérine and suspected cholérine.

On the other side of the harbor the population of El Wedj maintained an extremely good state of health.

During the period from the 8th to the 16th of December returning pilgrims came to El Wedj by way of the coast and overland (15 caravans with 1,800 pilgrims and 1,850 camels). These, without developing a single case of cholera during their fifteen days' quarantine here, finally departed for the Moses Well, there to undergo the final quarantine.

On the 19th of December the first ship with pilgrims from Yambo came into El Wedj, and several more soon followed.

On the 26th of December, Drs. Ardonin and Ferrari reported to the "conseil" that only on three ships were there scattered cases of cholera, on the other two none at all.

On that day the number of Hedjis collected in El Wedj was not less than 10,097; of these 3,255 were shipped from Jeddah and 3,643 from Yambo, whilst 3,200, inclusive of the large Egyptian caravans, had come by land.

On the 28th of December the first pilgrims forwarded to Tor were shipped from El Wedj, those among whom no disease had appeared for fifteen days.

But the three infected divisions from Yambo got rid of their cholera only very slowly. From the 27th of December to the 16th of January there occurred among them 5 well-marked fatal cases, and 50 with suspicious diarrrhea.

On the 8th of March the sanitary personnel after almost four months' service left El Wedj and returned to Suez. Altogether they had had under their care 12,417 pilgrims, of whom 341 died, 183 of cholera or suspicious diarrrhea, and 158 of other diseases.

The place was supplied with distilled water from two ships.

In Tor, where from the 29th of December to the 28th of March, 8,865 pilgrims were quarantined, 73 deaths occurred, among which in the first month there were a number from diarrrhea, which were not, however, registered as suspicious of cholera.

At Moses' Well, from the 9th of January to the 22d of March, 7,519 pilgrims with 2,867 camels passed their quarantine; no case in any way resembling cholera occurred here, only 13 pilgrims died of other diseases.

In Hedjaz, according to every account, the cholera was extinguished about the end of the year, and the Syrian caravans reached their places of destination in good health. After they had passed Medina they had no more cases of cholera.

Once more, therefore, had Europe happily escaped during a very dangerous period.

## THE CHOLERA EPIDEMIC OF HEDJAZ IN 1882.\*

As the cholera epidemic by which Hedjaz was ravaged in 1881 was preceded by the outbreak of the scourge in Aden caused by the *Columbian*, so had also the epidemic of 1882 a highly instructive prologue for the understanding of very important etiological questions.

On the 25th of July, 1882, the *Hesperia* entered the port of Aden after having left Bombay about the 12th of the same month with 501 pilgrims and a cargo of special wares for England taken on board.

During the voyage, according to the declaration of the captain, the ship had lost 6 passengers, of whom it was pretended that 4 had died of ordinary diseases (à propos of this Stékouli remarks —“a thing very curious that one of the victims aged thirty-five should have been attacked with *senile marasmus*”) and 2 had been washed overboard by a wave. As may be remarked here, it turned out later that the captain had brought with him 24 more pilgrims than the 501 indicated in the ship's papers; so that in this case also all control over the number of the fatal cases occurring was impossible.

One day after the arrival of the ship in Aden, on the 25th of July, an Egyptian stoker got sick on board with evident symptoms of cholera, and died on the 27th. In order to prevent a repetition of the occurrences of the last year, the ship was now at once sent to the Island of Camaran, where this year for the first time thorough preparations were made—all of the pilgrim ships coming from the eastern side of the Straits of Bab el Mandeb, before landing at Jeddah, being subjected to observation or a regular quarantine.

Scarcely were the pilgrims of the *Hesperia* landed in Camaran (on the 8th of August), when already two of them, who came from Buchara or Bombay, were taken ill with the most suspicious symptoms and died on the 10th of August. On the 16th and 18th followed a new death, each time a pilgrim from Buchara being the victim. The disease which now was recognized as undoubted cholera had in the first three cases lasted thirty-six hours, in the second only eighteen hours. In the next nine days, in spite of the most careful search among the pilgrims, by several European physicians, no new cases could be discovered; yet, as will soon be seen, the germ was not extinct, for on the 28th of August a fatal case of cholera again occurred, and from the 30th of August to the 13th of September twelve fatal and some non-fatal cases followed. Three-fourths of the passengers of the *Hesperia* were pilgrims from Buchara and Afghanistan. From Peshawer they had taken the railway in order to reach Bombay via Lahore; indeed, some of them traveled from Lahore to Calcutta and then first took the railway to Bombay, in order there to begin the voyage to Jeddah. How long the pilgrims had stopped in Bombay is not stated; but in any case they had in India ample opportunity for contact with the cholera germ.

After the departure of the *Hesperia* from Bombay almost a month had elapsed when the landing of the pilgrims in Camaran took place. The scourge had persisted here more than a month before it was extinguished.

Of 19 cholera patients in Camaran under professional treatment, not less than 17 died, and it must be belived that a number of lighter cases did not come to the notice of the physicians. The duration of the disease in the fatal cases varied between six and thirty-six hours.

Among the sick or dead were 13 pilgrims from Buchara, 4 Hindus, 1 Afghan, and finally a Turkish quarantine watchman. For ten days after the last fatal case, on the 13th of September, the health of the pilgrims remained good, and they were again taken on board of the disinfected *Hesperia* and transported to Jeddah. The cargo remained on board during the disinfection, and the latter could not, therefore, have been very perfect.

The total number of pilgrims congregated at Mecca during the feast—Kurban Bairam fell this year on 22d to 25th of October—was from 30,000 to 40,000. The health of that city remained good until October, but the dreaded guest made its appearance there according to Dr. Noury-Effendi, the Turkish sanitary officer, on the 25th of October during the feast of Mowna. In Mecca, from the 26th to the 31st of October, there were 192, and from the 1st to the 9th of

\* Report of German Commission on Cholera, Gaffky, loc. cit.



November, 109 cholera deaths. In Medina, where the disease was carried by the caravans, from the 5th to the 19th of November there were 250 deaths from cholera.

According to Dr. Mahé, the total number of victims in Hedjaz was 1,200 to 1,500.

The ships returning Egyptian pilgrims through the Suez canal were also this year subjected to quarantine at El Wedj, and thereafter also a quarantine of observation undergone at Moses' Well, without, however, cases of cholera making their appearance. The Syrian and Egyptian caravans arrived at their points of destination in good health.

It may also have a possible bearing upon the disputed origin of the epidemic of cholera in Egypt in 1883 to call attention to the fact that there was a brigade of Indian troops figuring in the movements of the army of the British occupation of Egypt in 1882.

#### CHOLERA IN HEDJAZ IN 1883.\*

Kurban Bairam fell this year on 11th to 14th October, in a time, therefore, when, as well in Alexandria as in Upper Egypt, the scourge had not yet ceased. In spite of this, Egyptian carpet caravans, as in other years, were permitted to be conducted on the long journey through the desert to the Holy City.

Concerning the state of health of upwards of 40,000 pilgrims congregated at Mecca, the news at first remained favorable. On the 14th of October the medical commission at Mecca sent a first dispatch to the "conseil" in Alexandria to the effect that on the second day of the feast in Mina (on the 13th October) cholera broke out, and in the course of two days 18 fatal cases occurred. Shortly after the scourge appeared in Mecca, where in the few days from 14th to 21st October, 19, 23, 38, 20, 46, 29, 36, and 20 pilgrims were respectively taken down daily. Up to the 4th of November the cholera deaths in Mecca showed a total of 451. Only the pilgrims were affected, whilst the native population was entirely free. On the return from Mecca to Medina, the caravan lost 150 dead, in Medina itself 64. In Jeddah, according to the information, only 8 cases of cholera with 6 deaths occurred among the Hedjis returning from the Holy City. On the 4th of November the epidemic in Hedjaz was well-nigh extinct.

Concerning the origin of the epidemic, again nothing definite is communicated. The sanitary commission were of the opinion that the Egyptian caravans had brought the germs with them, but it was asserted on the part of the physician accompanying the caravans that the latter en route as well as during their sojourn at Arafat and in Mina did not have a single case. From another source it is learned that in Mina, after the departure of the caravans, 16 graves were found on the spot where they stopped.

Moreover, it may be suspected that the cholera germ in 1883 also may have been brought direct by the Indian pilgrims to Hedjaz.

In this connection an interesting occurrence may be related, knowledge of which was received from the commission in Tor, and which was later confirmed by reliable persons in Suez. A short time before the beginning of the feast days in Hedjaz an English ship came to Camaran with pilgrims on board, in order to pass the required quarantine. There, however, the pilgrims perceived that by remaining the prescribed number of days in quarantine they could not reach Mecca in proper time, so they forced the captain by menaces, after remaining five days in Camaran, to break away and sail for Jeddah. The Turkish man-of-war stationed at Camaran pursued this pilgrim ship, but without being able to arrest it, and a few cannon shots sent after her were also fruitless. When the ship arrived at Jeddah it was forbidden by the port officers to land the pilgrims; nevertheless several hundred of the latter sprang into the sea in order to obtain their end in this manner.

#### CHOLERA IN EGYPT IN 1883.

Dr. Alfred Stillé, in a recent monograph on Asiatic cholera, gave the following brief history of the origin of the last visitation of Egypt by cholera in 1883:

"In 1881 cholera was brought from Hindustan to Arabia by pilgrims on their way to Mecca, where it soon afterwards broke out and caused the death of about 8,000 persons. In the fol-

\* Report of German Commission on Cholera, by Gaffky, loc. cit.



lowing year several vessels from Bombay evaded the quarantine and arrived at Jeddah, the port of Mecca, and the pilgrims on reaching the latter city disseminated the disease. The unusually small number of persons who were there at the time, and their prompt dispersion before the danger, limited the mortality, and gradually cases of cholera ceased to appear. In 1882, the English at that time carrying on war in Egypt, very rigid sanitary precautions against the importation of cholera were enacted and successfully enforced, but in the following year, the same urgent necessity no longer commanding, they were considerably relaxed. At the end of June, 1883, the cholera made its appearance at Damietta (at one of the mouths of the Nile), and soon afterward at Rosetta, Port Said, and Mansourah. During July it spread to various places in direct communication with those named. At Cairo it was peculiarly fatal, and on July 20 it was reported to have caused 600 deaths. For several days the mortality varied between 500 and 600. The disease prevailed somewhat in Alexandria during the height of the epidemic, and near the end of October it was fatal to numerous European residents of that city, and some deaths occurred in the British army of occupation.

“In all Egypt, during the week ending August 13, the total mortality is said to have been 5,000, but in the following week it fell to 2,000. It is estimated that from the 22d of June to the 1st of September, 1883, the cholera destroyed at least 50,000 lives. The germ of this epidemic has not been accurately determined. Some regard it as the survival of the cholera of the previous year—a supposition which is at least plausible and sufficient; but certain ‘sanitarians’ have attributed the outbreak to the ordinary causes of disease intensified by the civil war which had then recently devastated Egypt. It is sufficient here to say that while such causes have in all ages generated typhus and typhoid fevers and dysentery, they never produce cholera. Some, more unwise than judicious, declared that the Egyptian disease of 1883 was not cholera. It is alleged, on the one hand, that several East Indian merchants from Bombay arrived at Damietta on June 18, or three days before the disease was recognized in that city. It is also said that a stoker from on board an English steamer from Bombay introduced the cholera into Damietta. But the judgment of Surgeon-General Murray carries with it greater weight. He is of the opinion that the Egyptian epidemic of 1883 was simply a revival of the Arabian epidemic of 1882. He shows that cholera existed in several villages on the Damietta branch of the Nile in the latter part of May and during June, and that it broke out in the capital itself, during a fair which had lasted foreight days, on the 22d of June, and was spread by the people on their return from Damietta to their villages. ‘This,’ adds Dr. Murray, ‘is a literal transcript of the accounts of many of the severe epidemics that have raged over India.’ Dr. Peters describes with more detail the mode of origin and extension of this epidemic. At Damietta and Port Said at least 15,000 people congregated, in addition to the 35,000 inhabitants, to attend a great fair. The barbers who shave and prepare the dead are the first registrars of vital statistics in many Egyptian towns, and the principal barber of Damietta was among the first to die of cholera; and hence the earliest records of deaths were lost. The water supply of Damietta is obtained chiefly from a canal connecting two branches of the Nile. Mosques and many houses are on the banks of this canal, and their drainage goes into it. Every mosque has a public privy, and also a tank for the ablution which Mohammedans must practice before entering a holy place. There was, of course, great choleraic water contamination, and a sudden outburst of cholera took place. Only when the strangers had fled from Damietta, panic-stricken, was a rigid quarantine established and a cordon put around the town ‘to keep everybody in and let no one go out, neither food, nor medicines, nor physicians, nor supplies of any kind.’

“It appears from M. Proust’s narrative that the Ottoman Government had already, as early as April, notified the government of Egypt that certain Indo-Javanese pilgrims were on their way to Mecca, and that they ought not to be allowed to land without quarantine. The French delegate to the sanitary council also begged that those of the pilgrims who reached Suez without previous quarantine should be isolated and kept under surveillance for three days. But owing to the opposition of the English delegates these measures were not duly enforced, the council did not meet again, and no protective system was adopted.”

In a brochure entitled, "Some Notes on the Cholera at Damietta in 1883," W. I. Simpson, M. D., then medical officer of health, Aberdeen, Scotland, and now health officer of Calcutta, contributed one of the best accounts of cholera in Damietta that have been published, and it is inserted here in full:

In England, even with a special sanitary service, a medical registration of deaths, and no lack of medical men, there is often a difficulty in tracing an outbreak of epidemic disease to its first case. If the inquiry reaches so far successfully, a new difficulty arises, for one important step is still required, and that is to determine what was the cause of this first case. Was the disease imported, or did it originate *de novo*? Frequently it becomes evident that it was an importation, but as frequently the origin of the first case is wrapped in obscurity, and doubt is left on the investigator's mind whether it might not have originated spontaneously. We find some medical men explaining the commencement of an epidemic by spontaneous origin, and others equally convinced that this explanation is erroneous. As such differences of opinion exist here in a highly endowed country, it can be no matter of surprise that in Egypt, where civilization is of a different kind, and where facilities for investigation are absent, there is want of agreement concerning the cause of the recent epidemic of cholera. Some are of opinion that the recent cholera was imported, some that it arose spontaneously, and others that it is endemic in the country. The evidence on which these opinions are based is for the most part scanty, and one opinion, so far as proof goes, is worth as much as the other. It is in order to help to elucidate this important question that I have put together notes made during a few days' stay at Damietta.

Dr. Salem Pasha, the learned president of the board of health, through Dr. Grant Bey, of Cairo, kindly gave me every assistance in his power to forward my inquiries. In passing, I may mention that the German commission was there three days, and Dr. (now Sir William Guyer) Hunter one day. I found four days far too short, and regretted much I had no longer time at my disposal, for I was enabled to dip but slightly into the important problem.

In Egypt there are very few medical men, the demand for them being small, as the Egyptians are not in the habit of seeking medical advice. Excepting a few who have studied in European schools, the generality of the medical men know very little of medicine, and none have any conception of sanitary science.

The Government appoints a doctor to a wide district, pays him a small salary, and expects him to minister to the wants of the patients who may apply to him; but as the majority never apply, he is not hard-worked.

In Damietta there resides one doctor who is entrusted with the health of the people in the town and surrounding country. The population is estimated at over 30,000 inhabitants. The deaths are registered by a secretary, and the causes of death, gleaned from the statements of the friends, are put down in the register in a hap-hazard manner, much according to the tastes and preferences of the secretary. With such a wide area and so large a population, it is inconceivable that the medical man could have an accurate or even a general notion of the causes of death, except in the few instances where he has been called in during the illness. It is absolutely impossible that he should have any trustworthy information of the prevailing diseases at any particular time in his district. It is said that the local medical man should know best the most likely origin of the disease, but after the above explanation it will be readily discerned that all those advantages which, in other circumstances, he would have derived from special education, position, and experience, and which would have most fitted him to give a valuable opinion on the causes of the epidemic, or give material aid to other investigators, are entirely wanting.

To the stranger there are additional drawbacks to contend with. The Egyptians have a natural dread of being questioned, through fear of compromising themselves unawares. Possibly this fear is engendered by the arbitrary and despotic powers their superiors sometimes capriciously exercise over them. Whether this is so or not, the inhabitants have an unpleasant habit of stating whatever will suit themselves, or they express the views most in favor at the time, or contradict themselves so often as to leave one in doubt what they really know or mean



to convey. Numerous examples of this phase of their character came under my observation. I will mention two.

One morning a consul's servant, in great grief, told his master that his (the servant's) child had died the previous evening of cholera, and that two of the elder children were now attacked with vomiting and purging, and were seriously ill. Asked if he had sought medical advice, he replied, 'No, it was useless, for if his children died it was the will of God, and no one could prevent it.' The consul, however, insisted on a doctor being sent for. The man did as he was bid and informed the doctor of the child's death. An autopsy was suggested. This alarmed the father, and he immediately decided to say nothing about the other children, but hurried home and hid them. Afterwards he declared that they were quite well, and positively denied that he had ever said they were ill. He also induced a number of his friends to come forward and testify that the children were quite well, and that neither the elder children nor the one that died ever had vomiting or purging. The doctor saw the body of the dead child, and certified that it had died from diphtheria.

Another curious incident occurred when inquiry was made of a respectable man about his wife who had died of cholera. First he said his wife had died at a friend's house; a few moments after he declared she had died at home; and possibly thinking he had been too definite, he finally remarked he could not remember.

It is well understood at Damietta that the governor of the district is strongly of the opinion that the cholera was imported into Egypt by the English ships coming from India. This view suits both his political and social leanings, his hate for the English and his love for filth. From a reliable source I learn that the present governor has been in Damietta about six years. The town was in a much better sanitary condition before his administration commenced. It was then cleaner, and some attention was given to scavenging; now, cleaning is only a process for particular occasions. When it was understood that Dr. Hunter would visit the town, the inhabitants, by forced labor, were employed for three days in scavenging. The town underwent a similar purification before the visit of the German commission. The latter cleansing has been considered sufficient, for none has been done since that time.

Damietta is a small town of nearly 30,000 inhabitants, situated on the banks of the Nile, about 4 miles from the sea. The river just before it reaches the sea takes rather a sudden bend and runs into a deep basin. After passing the town, it again becomes shallow, and this shallowness is still further increased by the bar at the river's mouth. The result of this is that when the Nile is at low water the water in front of Damietta is slow-flowing, indeed almost stagnant, and whatever may at that time be thrown into the river is carried into the basin and remains there, and the same happens with any material from the town. When the river is high the current is then comparatively rapid, and sweeps away impurities thrown into it. The houses along the bank for the most part come quite up to the river side. Many small trading boats lie alongside these houses. The boats come chiefly from the small islands in the Archipelago, from Greece, from the Syrian coast, and a few from Port Said. Those from Port Said have two routes—some come by sea, others cross the Menzaleh Lake. The sailors are chiefly Greeks, Syrians, and natives; there are no English among them. There is plenty of communication between Port Said and Damietta, for many of the former inhabitants of Damietta have left and reside at Port Said, so that there are always natives crossing over from Port Said to their friends and relations at Damietta, and *vice versa*. There is also an interchange of merchandise between the two towns. The manufactures in Damietta are silk and cotton goods. The people, who appear to be poor, are fond of fish, which they seem to prefer in a rather putrid state. The chief institution in the town is the fish-market. There are numerous cafés, frequented by sailors, mostly Arabs and Syrians. There are no squares, gardens, open spaces, or places of recreation. The whole town consists of narrow, irregular, unpaved, and undrained lanes. The site is low-lying, and the soil, consisting of alluvium deposited by the Nile, is damp, and after rain it is swampy. The air is odorous with nauseating and miasmatic vapors, constantly given off from stagnant pools filled with decomposing animal and vegetable matter. Green pools, with gases bubbling up from them, are seen in every part of the town.



It had been raining the day before I arrived, and it was amusing to see the Arab children take off their scanty clothing, enter the puddles in the streets, play, bathe, and roll in them, and come out covered from head to foot in a coating of mud and mire. Even in the best parts of the town it was difficult to go from one side of the street to the other.

The inhabitants, when they trouble themselves to be so far cleanly, which I am given to understand is not always the case, and of this I myself had ocular demonstration, throw all their slops and refuse in front of the door or near the dwelling. This practice is the cause of the above-mentioned fermenting mass of half-solid and half-liquid matter; there it lies, rots, soaks into the soil, and gives forth its offensive and dangerous exhalations. The street and surroundings of the house are the common sewer and cesspool for the town. Of all the disgusting places, offensive alike to the sense of sight and smell to a European, the latrines and baths attached to the mosques are the worst, because of their overpowering stench. Long before they are reached the evil odor they send forth distinguishes them. The cemeteries also add their share, and in this town of filth and stinks there is not one redeeming feature.

The impression given to the visitor is that Damietta has been a larger and more important town than at present; the houses appear to be too numerous for the sparse inhabitants. The best-class houses are large and fairly built, but are very old and falling into ruins. Invariably the lower apartments are uninhabited, generally used for stores or rubbish, and always very filthy. In the quarter where the cholera first violently broke out, and in many other parts of the town, the houses are one-storied, badly built, and half in ruins. They are chiefly made of a compost of mud, manure, and straw. The floor is simply the soil on which the hovels, for they can be called nothing else, are erected. There is frequently a slightly raised portion of the ground which does duty for a bed; on this there may or may not be a mat; several apertures in the sides of the hut near the roof act for windows and ventilators, but little air or sunshine gains admission by these holes, so that the inside of the dwelling is dark and sometimes damp. It is often strewn with rubbish. There is no furniture, but sharing the cabin are such animals as the inmates may happen to keep.

The inhabitants live mostly out of doors, and use their houses chiefly for shelter at night. Those who live in the houses on the banks of the Nile, or near the canal which runs through the town, empty their refuse into the water; they also wash their clothes, utensils, and themselves in the Nile or canal, and draw their drinking water from the same source. I have seen a woman empty the filthiest liquid into the river, and another woman come immediately after and fill her pitcher with water for drinking purposes from the same spot before the water had become again clear. The Arabs do not filter their water, but prefer it from the Nile with whatever it may contain. To them filtered water is as distasteful as distilled water to most people.

All European notions of sanitation are outraged in this town. I have mentioned pollution of soil, air, and water. I have yet to add tainted and diseased meat. It was about the beginning of February that bovine typhus broke out at Damietta, and extended up the river to other villages and towns. Though there is no direct charge exacted for burying these animals, there are indirect ones, and the owners prefer to throw the carcasses, minus the hides, into the river, both because it is easier and because it costs nothing. Mr. Goodall, who was employed by the Egyptian government to superintend the clearing of the east branch of the Nile, and with whom I had the advantage of a conversation, took out 400 putrid carcasses in one week, most of them being in the vicinity of Damietta, and the majority of them being in such a decomposed condition as to make it impossible to drag them out of the river except in pieces. The work was of an intensely offensive and sickening nature, and the carcasses as they accumulated produced a pestilential state both of the air and of the water. This cattle plague had appeared in and around Damietta in the four previous years, but not to the same appalling extent.

Notwithstanding the insanitary condition of the town which I have described, Damietta is to the Arab's mind a healthy spot. It is cooler than many parts of Egypt. The native

physicians send their patients here to recover their health; whether they do so or not is another matter. The idea of Damietta in its present condition as a health resort seems to be about the most distorted fancy ever entertained, and reminds one of the notion of the Spanish physician of a former century, who maintained that human ordure kept inside houses was good for health, because it absorbed all noxious vapors. There are some smells, however, that the Egyptians strongly object to, namely, those of carbolic acid and chloride of lime. It is believed that they produce abortions and other untoward accidents.

The general state of health in Damietta may perhaps be gauged by the number of deaths.

This table shows the number of deaths in the several years from 1860 to 1882:

Year.	Deaths.	Year.	Deaths.	Year.	Deaths.
1860...	1,103	1868...	911	1876...	1,591
1861...	941	1869...	1,004	1877...	1,449
1862...	1,502	1870...	929	1878...	1,259
1863...	1,096	1871...	1,143	1879...	957
1864...	1,092	1872...	1,230	1880...	1,237
1865...	2,747	1873...	1,274	1881...	1,112
1866...	987	1874...	1,196	1882...	1,061
1867...	1,120	1875...	1,537		

Whether all the deaths are registered I am unable to say. The above is the official death-return. The healthiest year has a death-rate of nearly 30 per 1,000. Some years have 50 per 1,000. The cholera year of 1865 has over 100 per 1,000, and there were over 100 per 1,000 in 1883. No wonder Damietta looks desolate.

To those responsible for the good sanitary condition of a country it is not palatable to have it asserted that a disease has arisen and ravaged the country from neglect of duty on their part, and it is quite to be expected that the accused would seek out some other cause than the one which brings the blame home to themselves. The members of the Egyptian board of health are just now in this position, and naturally enough cling to the opinion that the recent cholera was imported, and that it spread by contagion independently of any sanitary conditions. They believe that it came from India. So far as importation goes, they are, I understand, supported in their views both by the French and German commissioners.

Before stating my opinion about importation it may be useful to compare the two epidemics of 1865 and 1883 with regard to time, duration, and intensity.

The following shows the deaths in the epidemic of cholera in Damietta:

Date.	Deaths.	Date.	Deaths.	Date.	Deaths.
1883.		1883.		1883.	
June 22 ...	6	July 10 ....	52	July 23.....	3
23....	13	11.....	65	29.....	5
24....	15	12.....	40	30....	2
25....	21	13.....	38	31.....	3
26....	37	14.....	38	Aug. 1.....	6
27....	113	15.....	35	2.....	
28....	101	16.....	27	3.....	
29....	113	17.....	18	4.....	3
30....	110	18....	17	5.....	
July 1....	141	19.....	22	6.....	2
2....	130	20.....	7	7.....	
3....	110	21.....	14	8.....	3
4....	111	22.....	6	9.....	
5....	109	23.....	8	10.....	
6....	107	24.....	16	11.....	
7....	92	25.....	5	12.....	
8....	88	26.....	4	13.....	1
9....	53	27.....	3		



The two epidemics show some interesting points of resemblance. They commenced about the same time of year, when the Nile was at its lowest. They caused within five or six days of their appearance over 100 deaths a day. They continued at a high death-rate for ten or eleven days, and then they gradually subsided, and disappeared about the time when the Nile had considerably risen. The epidemic of 1865 lasted fifty days and destroyed 2,376 persons, and that of 1883 lasted fifty-three days and destroyed 1,928 persons. The only material point of difference is that the epidemic of 1883, in spite of all its attending circumstances of filth, diseased meat, and polluted water, was actually less severe than the previous epidemic. This, however, may be accounted for by the active measures taken to clear the Nile and by the steps adopted to purify the town; but a more potent agency, in my opinion, than these and others put together was the earlier and more rapid rise of the Nile. It gave clear and fresh water to the people, in spite of their filthy habits. It was like a new water supply granted to them and seemed to have the almost immediate effect of staying the epidemic. Whatever may have been the origin of cholera at Damietta, there is little doubt its rapid spread was mainly due to the defilement of the water.

There seems to have been no doubt about the origin of the cholera epidemic of 1865. It was clearly an importation. That of 1883 has not, however, been so clearly ascertained, perhaps owing to the inherent difficulties surrounding the investigation, especially when increased by the political and commercial spectacles through which, unfortunately, the whole question was viewed from the very first.

In support of the theory that in 1883 the cholera was imported either directly or indirectly from India, two persons are particularly mentioned as being likely carriers of the disease into Damietta: (1) Mohammed Khalifa, a fireman on board the *Timor* from Bombay; (2) Ayouzi al Zendaia, a woman trading between Port Said and Damietta.

When Khalifa was first put forward as the importer of the disease, Dr. Chaffey Bey and Dr. Ferrars showed very conclusively he did not arrive in Damietta until after the outbreak had commenced. He was in prison at Port Said on the day when the cholera broke out. The authorities at Damietta now state that some important facts have been omitted by the doctors. The governor informed me he had proof in his hand that Khalifa visited the town immediately on leaving his ship, and it was only after his return from Damietta to Port Said that the governor of the latter town put him in prison. According to a written statement I received from the governor, Khalifa arrived at Damietta on the 13th or 14th of the Challan, which corresponds to the 19th or 20th of June. He came to visit his parents, who reside in the town, but on that day, not expecting their son, they had gone over to Port Said. Khalifa therefore went to a café in Damietta, much frequented by sailors (kept by Salem el Sandouli); there he got into trouble, was arrested and put in prison, where he remained until his parents returned and begged for his release, which the governor granted. After this, Khalifa started off for Port Said, and conducted himself so noisily in that town as to be arrested and imprisoned. A few days after Khalifa's visit to the café, Salem el Sandouli and his assistant died of cholera; further, their deaths occurred on the same day. Both men lived in a quarter of the town where the cholera first broke out violently, which was a considerable distance from the café. These are the facts in support of Khalifa having imported the cholera. He seemed to have been fixed upon simply because he was the only one in Damietta who had a remote connection in Bombay. I made particular inquiries into the sickness and death of the two café men, and ascertained they were only ill one or two days. They died on June 28, *i. e.*, eight or nine days after Khalifa's visit. They were by no means the first attacked by the disease in the quarter in which they resided, nor had Khalifa visited this part of the town. On June 22 there were 6 deaths from cholera, on the 23d 13 deaths, and more, in daily increasing numbers, before either of these men took ill. They were well while those around them were dying fast, and they only became victims of the cholera *after* a large number of their neighbors had succumbed—on the day, indeed, when there were 101 deaths. To suppose that these men, even if infected by Khalifa, had spread the disease before they took ill, or to such an extent, is to suppose an impossibility. Moreover, Khalifa himself was never ill; from all description given of



him he appears to have been drunk, and it is quite certain he did not come from an infected ship. Granted here that there had been some facts omitted, and that Khalifa had visited Damietta immediately on leaving his ship, there is still not the slightest evidence to connect him in the least degree with the epidemic.

The second case brought forward is as deficient in proof as the first. A woman named Ayouzi al Zendaia some years ago lived with her mother in Damietta, but, getting married, she removed to Port Said. In the latter town she began business, and carried coffee, silk, etc., from Port Said to Damietta, returning with other exchanged articles of merchandise. When in Damietta she usually visited the house of Mohammed Dalia. In this house lived a woman named Fatma. Fatma and Zendaia were great friends, and on these visits frequently spent a long time in each other's company. Fatma, knowing how to do Syrian cooking, was invited by Ali Markili, a friend, to a banquet, in order to prepare a Syrian dish. She went to the house on Tuesday, June 19, was attacked with vomiting and purging the same day, and died the following night. Soon afterwards the negress servant of Ali Markili died of Cholera, and in a few days the wife of Ali Markili herself.

The movements of Zendaia were as follows: She arrived at Damietta from Port Said on Challan 6, which corresponds with our June 12. She did not see the Syrian woman who lived in the same house until June 16, but in the mean time went over various parts of the town. When the two women met they remained in each other's company the most part of the day. On June 20, four days after the first interview, the Syrian woman was dead. Twelve days after the arrival of Zendaia, the wife of Mohammed Dalia, the owner of the house, died of cholera. A few days before the death of the landlady Zendaia visited her brother, residing on the other branch of the river Nile, and two days after the visit the daughter of this brother is said to have died of cholera. On June 24 Zendaia departed for Port Said, and three or four days after was attacked with cholera herself. An examination of the register of deaths gives some information bearing on the above statements. It shows:

(1) The Syrian woman died on June 20, registered acute gastro-enteritis.

(2) The wife of Dalia, the owner of the house, died on June 24.

(3) The negress servant of Ali Markili on June 29.

(4) The wife of Ali Markili on July 1.

(5) The name of Zendaia's niece could not be found in the register. (Since my arrival in England the date has been kindly forwarded to me; it is put down as July 15.)

If Fatma was the first person attacked with cholera at Damietta, it is possible the wife of Dalia, living in the same house, caught the infection from her. It is, however, very improbable that the death of the negress servant or of the wife of Ali Markili was due to Fatma's visit before she showed any signs of illness; but the deaths were more probably due to that general cause which was destroying at the time over 100 persons a day.

Even if Fatma was the first attacked with cholera in Damietta there is no evidence of any worth to show that Zendaia brought the disease with her; nor is it traceable that any one else brought it to the house.

As mentioned before, Zendaia herself was attacked with cholera at Port Said on June 27 or 28, eight days after the death of Fatma. Instead of Zendaia importing cholera into Damietta, she became infected at Damietta, and was one of those who conveyed the cholera to Port Said.

These cases, or others of a similar kind, do not explain the origin of the epidemic; besides, in the several investigations the deaths alone have been considered. Because there was one death distinctly choleraic on June 20, and six deaths on the 22d, June 20 has been hastily decided upon as the first day in which cholera appeared in Damietta. My investigations, however, led me to a different opinion, namely, that cholera was present in Damietta before it ever came to the public notice, not in an epidemic form, but gradually accumulating its energy for the apparently sudden outbreak.

If we look at the monthly deaths for 1882 and 1883 we see a greater number in the months of January, February, March, April, and May for the year 1883 than for 1882.

The excess in the number of deaths appears to be largely due to extra bowel complaints.

It should be borne in mind: (1) The register was not kept correctly with regard either to entries of death or names of diseases. There were causes of death put down which even the native doctor did not comprehend. (2) The case claimed by the authorities to be the first case of cholera was registered acute gastro-enteritis. (3) For at least two months previous to June 20 there had been an unusual number of cases marked down acute gastro-enteritis.

Besides these there was the additional fact that before cholera became epidemic an unusual sickness, consisting mainly of diarrhea and vomiting of a very prostrating kind, was prevalent in and around Damietta; many deaths were caused by it.

There came to my notice many instances of people having suffered; some of the more trustworthy may be particularly mentioned:

(1) A woman called Houria Manne, who made and sold bread, was on May 4 attacked with vomiting, purging, and cramps in the limbs. Her whole body became unnaturally cold, her eyes were sunken, and she was only able to speak in a whisper. The diarrhea and vomiting lasted two days and then suddenly ceased, but the woman was so debilitated as to be quite unable to rise from bed until ten days after. During the epidemic she saw many of her friends and neighbors attacked with cholera, and is confident her illness was also cholera.

At the time of her illness a young man was attacked in a similar manner in the same house.

(2) On May 14 a barber in the town was attacked with diarrhea, vomiting, and cramp. He was taken home, and it was several days before he recovered. A friend who was with him at the time had a similar attack. The barber's son died in the same month after a few days' illness. The death was registered typhus fever, but so far as I could ascertain most of the symptoms consisted of vomiting, purging, and rapid collapse.

(3) The wife of the servant of the acting German consul was attacked with choleraic symptoms on June 1.

(4) The servant of the Austrian consul was attacked with all the symptoms of cholera on June 4. But if these and others which I have not mentioned were sporadic cholera cases, why did it not become epidemic at once?

The explanation appears to me to be this: The cholera poison was present in the town, but could not assume an epidemic form until the drinking water was thoroughly contaminated. This happened when the Nile had reached its lowest point, and continued for the first few days after the Nile had begun to rise. The cases here and there in various parts of the town a month or two before were from local contamination of the water kept in the house. There may have been a few instances from direct contagion, but nine-tenths appear to me to be due to some other cause than direct contagion. Although the origin is pushed back to an earlier date, the question still remains, were the cases in the earlier part of the year due to importation or spontaneous generation? I think we may put endemicity aside. If the disease had been endemic in Damietta, it had more opportunities when the Nile was low of becoming epidemic. That it did not is fairly certain, for however incorrectly the register books may be kept, an epidemic of considerable size could not pass unnoticed. Whether the disease was endemic in other parts of Egypt I am unable to say. In the villages of Upper Egypt, where most of the diseases are registered as caused by the evil spirit—or devil—there is no surmising what diseases may be present. I can not say I am much in favor of a spontaneous generation, although it must be admitted, if ever a state of filth, in its general sense of pollution of soil, water, air, and food, produced cholera, Damietta possessed the wherewithal in a high degree. My time did not allow me to examine this point as it deserved.

In regard to importation there was one curious fact which struck me. Several of the sicknesses and deaths from acute gastro-enteritis were amongst devout and religious people. Could the cholera be traced to some returning pilgrims from El Hedjaz about December, 1882? And this is more likely since cholera was prevalent at Mecca at that time. If inquiries were made in this direction I think they would probably be crowned with success—unlike those purporting to prove the direct importation of cholera from India into Damietta through Port Said.



As a result of my visit to Damietta I can confidently assert that the cases hitherto brought forward, whether of sailors or of Indian merchants or of natives bringing cholera into Damietta, fall to the ground when strictly scrutinized. The Arabs do not attach much importance to dates, so that details which appear conclusive enough to them do not bear analysing; but though the cases brought forward do fall to the ground, I am sensible that this fact does not disprove importation, for the cholera may have been imported in some other way, such as I have indicated.

The purport of the foregoing notes may thus be summed up:

(1) The sanitary condition of Damietta is unusually bad, even for a town in Egypt.

(2) The cases alleged to have been the means of introducing cholera into the district, upon examination entirely break down.

(3) There were cases occurring with all the characteristics of cholera before the prominent outbreak.

(4) There is room to suspect the true introduction may have occurred through the return of pilgrims.

(5) The endemic origin in Damietta can not be well supported on account of the long interval between the two great epidemics, with unusual facilities present almost every year for it becoming epidemic. It is not intended hereby to deny its alleged endemicity in the upper parts of Egypt.

There is one important point forgotten (by the Egyptian government), that whether imported or not, the epidemic assumed its gigantic proportions by the utter disregard of cleanliness. A people that does not provide for the safe removal of its effete matter, but allows it free access to the drinking water, are practicing habits which are not only a danger to themselves but also to all European nations who have communication with them. Quarantines, *cordons sanitaires*, and other similar devices, are abused. Except at the time of terror they are only partially carried out, and nothing after all is beyond a bribe.

When in Egypt it was to me a matter of regret to see other nations, such as France and Germany, send out scientific medical men especially to investigate, not only the origin of the recent epidemic, but the nature of the poison or germ, while England was content with cleaning up and sending medical aid. This action on her part was no doubt the most efficacious at that time, but since she possesses the largest part of the commerce from Egypt and through the canal, surely it was to her best interests to learn exactly how the epidemic arose. With knowledge acquired it would have been easier to have prevented another outbreak. Other nations clamor for quarantine; a long quarantine bears no value in Egypt.

Sir W. G. Hunter\* described the general sanitary condition of Egypt and the appearance of cholera there in 1883, as follows:

Egypt is a very extensive country. It extends from the Mediterranean Sea to the equator. It is not, however, this vast country which has been the scene of the recent epidemic of cholera, but rather Egypt proper, which includes the Delta and Upper Egypt as high as Assuan on the first cataract. Its area of cultivated land is not larger than Belgium. Its population, however, according to the most recent census (1882) amounts to 6,798,280, and is, consequently, about one and a quarter millions in excess of that of Belgium. The soil, which is very fertile, is an alluvium, 'the gift of the Nile,' and is rich in decomposing organic matter. The people are essentially agriculturists, and lead an outdoor life. Manufactories, though increasing, are comparatively few. It is almost a rainless country. At Alexandria, it is true, the average rain-fall for the last four years has been about eight inches, but in the interior, of which Cairo may be taken as an example, the rain is limited to a few showers, which fall during the cold months of the year, viz, in November, December, and January. The sky is generally cloudless, the air dry, and the dews very heavy. The prevailing winds are northerly, a southerly wind being quite exceptional. On looking over the meteorological

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\*British Medical Journal, January 19, 1884.



reports issued from the Khedivial laboratory one is struck by the almost tedious monotony with which the northern winds blow throughout the year.

The rain-fall being so scanty, the country is consequently dependent on the Nile for its water supply. The river is subject to periodical inundations, owing to the heavy rains in the equatorial regions. The rise of the river at Cairo begins about the end of June, and is at its highest about the middle of September, when it gradually falls until it again attains its minimum level in June. There being practically no rain, the subsoil water levels must necessarily follow the Nile level, that is to say, be at their lowest in June, and at their highest in September.

The larger majority of the people drink the water unfiltered, and generally before it has been allowed time to deposit. It is said that they prefer it in this condition. In Cairo the quality of the water supply is indifferent. At the water-works there is but one settling-tank, and as it is in constant use it can never be cleaned.

The large amount of mineral matter contained in Nile water, while settling, carries down with it no inconsiderable quantity of the organic substances held in suspense in the water, and must lead to rapid fouling of the tank. Filtration is effected by gravel and sand. In the Ismalia quarter, that is, the fashionable quarter of the city, and in the Boulac quarter also, no attempt is made to filter the water, but it is supplied as obtained from the Nile. Close to the intakes of the Cairo water-works, where some slight efforts, it is presumed, would be made to prevent pollution of the water, I have seen human and other animal excreta, fresh and stale, lying about in various directions, and men and women bathing, and washing their soiled clothes in the river. This was by no means an uncommon sight.

The water supplied to Alexandria, on the contrary, is of very good quality. The system, though much the same as in use at Cairo, is carried out in a much more efficient and thorough manner. Alexandria is the only town in Egypt which possesses a wholesome supply of water.

The river and soil have been polluted through countless generations, and the alluvium is almost as absorbent as a sponge. Wherever there is water, it is scarcely too much to say you may feel assured it has been fouled by man. The river is, I may say, polluted and fouled almost from its source. It is the means by which filth, garbage, and dead animals of every description are disposed of. Every town and every village situated on its banks add their quota to the fouling of the stream, until at length, when it has reached its lowest level in June, it is found, as at Cairo and Damietta, to be undergoing putrefactive changes; to present under the microscope the character of pond-water rather than of a running stream, and to contain bacterioid organisms in considerable quantities.

For a detailed description, chemical and microscopic, of the character of the water at Cairo and Damietta, in June, 1883, I would beg to refer to my second and third reports to Her Majesty's Government on the recent epidemic in Egypt. Mr. Ismalum, director of the Khedivial laboratory at Cairo, and Dr. Sonsino, in their report state that after July 20 bacterioid bodies were no longer found in the water.

As a specimen of the quality of the water used by the villages in Egypt, I would, in passing, call attention to a report made to me by Mr. Honman, one of the twelve medical gentlemen sent to Egypt by Her Majesty's Government for service during the epidemic. This gentleman was in charge of Mehallet-el-Kibir, a town of about 28,000 inhabitants, situated to the north of Tanta, midway between the Rosetta and Damietta branches of the river. Mr. Honman states in his letter, dated August 30, 1883: 'The town has three mosques, the drain from one running through the town, quite open and with 3 feet of filth at the bottom. This discharges itself into a pool of water at the back of the town, which is used by the people for domestic purposes, and as drinking water for their cattle. The other two mosques drain in a like manner into pools outside the town, and they also are used by cattle and for domestic purposes. The stench from these drains can be smelt all over the town.'

During the past year the water-ways were more than ordinarily polluted by carcasses of cattle which had died of typhus being thrown into them, in order to evade a tax of 5 francs

per head for their burial, which the poverty-stricken fellaheen were quite unequal to pay. It is notorious that many of the fellaheen were reduced to such straits as to be forced to feed on the carcasses of cattle which had died in this way. The number of carcasses and portions of carcasses in a far advanced state of decomposition removed from the Damietta branch of the river amounted to upwards of 1,500, a number considerable in itself, but insignificant as compared with the thousands which must have been thrown into the river. The losses in cattle occasioned by the 'epizootic' weighed heavily on the fellaheen and reduced them to strange and curious expedients to till the soil.

The villages are collections of mud hovels, in which, with the human family, reside all their domestic animals, as pigeons, fowls, asses, goats, and perhaps a camel. In no towns, so far as I know, are there public latrines, except those belonging to the mosques, which are quite inadequate to meet the wants of the people, who are driven to the streets, gullies, and open spaces for natural purposes. This remark applies equally to cities like Cairo and Alexandria.

I must here for a moment interrupt my narrative in order to pay a passing tribute to the valuable sanitary work effected by the executive commissions which the exigencies of the times called into existence at Cairo and Alexandria. Shortly after the epidemic ceased in the Delta, these commissions were dissolved, with a result that might have been foreseen; grossly unsanitary conditions again became rife, and have justly called forth from Mr. Clifford Lloyd the severest reflections on the health inspector of Alexandria and the conseil de santé at Cairo.

In Cairo the cess-pit system exists, and is carried out in a very inefficient manner. Many of the pits are holes dug in the sand, which have never been emptied or cleaned. More recently, in the better classes of houses, the pits have been better constructed, but their being emptied depends much on 'the caprice of the landlord, not of the tenant.' The wooden carts employed for the removal of the sewage are of the most primitive description, and numerically are quite insufficient for the purpose. Consequent on there being no break of connection, the house-pipe and the cess-pits are in direct communication one with another.

In Alexandria an attempt has been made to establish a sewerage system, but, as in most things Egyptian, a very defective one. In the first place, it is but partial; in the second, it possesses radical defects of construction, and the outlets, some twelve or more in number, pour their contents onto the beach directly to windward of the city. The sewers are, moreover, unventilated, such ventilators as existed having been sealed up about five years previous to my visit in August last. The privies of the houses are in direct communication with the sewers.

I might point to numerous other unsanitary conditions, not in Alexandria and Cairo only, but in the country generally, but refrain from doing so. It will be sufficient to say that grossly unsanitary conditions abound everywhere, and there can be little doubt that from their sanitary department the Egyptian government have received but scant service. It is to me a source of much satisfaction to know that the conseil de santé has been abolished, to be, I trust, replaced by an executive which will not be neglectful of its duties to the country and the people. Under such conditions as I have above faintly endeavored to describe it is hardly a matter of surprise that bowel disorders should be very common and very fatal, and zymotic diseases very prevalent. Visit what hospital or village one may, one is struck by reports of the prevalence and fatality of diarrhea, enteric fever, and other intestinal disorders. And that, under the head of diarrhea, numerous deaths from cholera lie hidden, I shall proceed to show further on, from evidence supplied to me by others as competent as myself to form an opinion on the subject. Registration of disease is notoriously defective in the smaller towns and villages of Egypt. It is generally not until after death, when it may perhaps be necessary to obtain a permit for burial, that an attempt is made to ascertain the cause of death, and even then, as a rule, it is as often guessed at as not. Although the system be highly defective, yet it must not be lost sight of that all the returns and reports agree on the prevalence and fatality of disorders of the bowels. Samanood and Shibin-el-Koom were two towns among others which I visited while in Egypt. At the former, from the 1st to the 30th of June, 1883, out of



40 deaths from all causes 25 were from diarrhea. At the latter, out of a total of 174 deaths in May, June, and July, 1882, 93 were from diarrhea; in May and June, 1883, out of a total of 110, no fewer than 57 were from diarrhea. In Cairo, where registration, though far from perfect, is more reliable than in the smaller towns and villages, the mortuary returns show a very high death-rate resulting from bowel disorders. It will be observed, from the mortuary tables of that city for 1881 and 1882, which are placed before them, that in the former year, out of a total death-rate of 14,579, or 39.67 per mille, there were 1,097 deaths from gastric and typhoid fever, or 7.5 per cent.; 1,889 from dysentery, or 12.9 per cent.; 1,902 from gastric catarrh, or 13 $\frac{1}{3}$  per cent.; that in the latter year (1882), out of a total death-rate of 17,290, or 46.98 per mille, the death-rate from the same causes was 10 per cent., 13 $\frac{2}{3}$  per cent., and 15 per cent. respectively—a startling mortality as compared with a city like Bombay, for example, where the death-rate from all causes for 1881 amounted to 27.87 per mille, and from bowel complaints a rate of 2.59 per mille.

Typhus fever is far from being uncommon, and in 1883, I have reason to believe, prevailed to some extent in the towns and villages of the Delta. In the returns for Cairo for the years 1881 and 1882, previously referred to, 35 and 46 deaths respectively are registered from this cause. Little aid need be looked for from examination of the hospital registers of the smaller towns and villages, as in the majority of instances the medical officers are incapable of differentiating between typhus and typhoid types of fever; and under the latter heading many examples of the former would not unlikely be found.

The recent war, too, not improbably exercised a peculiar influence in the general insalubrity of the country. Relatively, however, to other existing conditions, this influence could not have been considerable. The campaign was a very short one; its main operations were conducted in the desert—between Ismalia and the Delta—outside, as it were, of the country. The men composing the ‘Indian Division of the Egypt Expeditionary Force’ were a picked body; and Deputy Surgeon-General Colvin Smith, C. B., principal medical officer with the force, in his report of the expedition, states that the fighting men and followers were remarkably ‘healthy;’ that it was not until they had been resident in Cairo that their health began to suffer from diseases common to the country, as diarrhea and enteric fever, both of which diseases he seems to regard as endemic in the city. From diarrhea, he states, almost every officer suffered while at Cairo, and some very severely.

There have been in Egypt, since 1831, no fewer than five epidemics of cholera, exclusive of that of 1883. The first broke out in July, 1831; the second on June 24, 1848; the third on July 25, 1850; the fourth on June 24, 1855; the fifth on June 11, 1865. The last, according to official reports, claimed 61,192 victims—a number, I imagine, much understated, unless registration was more efficient than it was during last year.

I am, I regret to say, unable to give the loss in population caused by the recent epidemic, as the returns are not made up. The authorities are waiting until the disease has, I presume, ceased to exist. Now, however, that public attention has been directed to the matter, I fear some considerable time must elapse ere the report be published. The disease clings to the country—*hæret lateri letalis arundo*—even as in years gone by; but its presence now is recognized and acknowledged, a marked advance in sanitary politics in Egypt, and it is to be hoped of good augury for the future. Better far an open enemy, whose attacks can be met, than a hidden foe, who, invisible, deals his death blows with an unsparing hand and creates a wail through the length and breadth of the land.

Having thus, however imperfectly, and in as concise a manner as possible, endeavored to describe the chief physical features of the country, its gross unsanitary conditions, and its more prevalent diseases, I think that it will be admitted that never was there a country more ripe for an outbreak of epidemic disease, such as cholera, than Egypt; and yet Egypt itself was apparently astounded when it was announced that cholera, or plague, had broken out at Damietta on June 22, 1883. Immediately the report reached Cairo a commission was deputed to investigate the matter. The commission arrived at Damietta on June 24, and reported that the disease was cholera, but found it impossible to come to any conclusion as to its genesis.



‘La Commission se trouve dans l'impossibilité d'établir la genèse du choléra-épidémique de Damietta.’

Dr. Flood, physician to the hospital at Port Said, believed (Drs. Chaffey Bey and Ferrari state in their report, to be referred to presently) that he had found the key to the enigma, and reported on July 5 to Salim Pasha, the president of the conseil de santé, that the disease had been imported by Mohammed Khalifa, a stoker belonging to the *Timor*. This statement of Dr. Flood's has justly come to be looked on as incorrect, and, shortly after it was put forward, was effectually disposed of in a telegram from Sir E. Malet to Her Majesty's Government, dated Cairo, July 11, 1883, which was as follows:

“Mohammed Khalifa, for some years inhabitant of Port Said, shipped as fireman on board steamer *Timor*. Made voyage to Bombay, returning 18th ultimo; all on board in perfect health. Obtained discharge at Port Said, and commenced course of drunkenness and excess. This continued for four days, when he was imprisoned by governor of Port Said, and finally expelled by that official on 23d ultimo, and arrived at Damietta on 24th, when he recommenced same course of excess on 25th. He is now at liberty, and apparently in perfect health. This disposes of theory, as epidemic broke out at Damietta on 22d.”

The next inquiry into the origin of the epidemic was carried out, under the instructions of the quarantine board, by Dr. Ahmet Chaffey Bey and Dr. Salvatore Ferrari; they are both medical officers of experience and of high standing in their profession. That report is dated Damietta, July 24, 1883, and will be found, in extenso, in my second report to Her Majesty's Government. These two gentlemen, firmly convinced of the importation of the disease, expected to obtain a confirmation of their views. Instead of this, after careful and patient investigation, they were forced to the conclusion that the disease had not been imported, and that there existed, in the deplorable unsanitary condition of Damietta itself, sufficient cause, in their opinion, for the origin and development of the disease.

Its importation into the country has, also, I believe, been assigned to the Indian contingent during the war. I have, however, never seen this hypothesis formulated. This absurd opinion would seem to have had its origin in the representation made by M. Fauvel, inspector-general of sanitary services under the French Government, of the danger which he conceived would arise to the French troops, which it was then expected would be sent to Egypt, from their association with the troops coming from India. As the contingency happily never occurred, it is not possible to say whether M. Fauvel's doleful foreboding would have been realized or not. Whether this opinion of M. Fauvel's had been twisted to serve the purposes of those who believe in the importation of the disease into Egypt, I am scarcely prepared to say. Be that as it may, the subject has been allowed to drop.

The last importation theory which has been advanced is one by Dr. Mahé, delegate of the French Government, viz, that it has been introduced by coal trimmers and stokers employed on board steamers running between Bombay and Port Said. The ingenuity and vagueness of this allegation will be at once apparent. The subject is being investigated by Her Majesty's Government. The inquiry is likely to be a protracted one, but that Dr. Mahé's views will share the fate of those which have preceded them, I, for one, can not for a moment doubt. The necessity for any investigation seems to me doubtful, considering that conditions already existed in abundance in the country itself to account for the origin and diffusion of the epidemic, not in the Delta alone, but also in towns and villages in Upper Egypt, far removed from the line of traffic between Egypt and India. Dr. Couvidon, a French physician resident at Port Said, in a report addressed to the French consul, dated August 1, 1883, says it is not easy to determine the exact motives, either individual or general, which attribute the epidemic to importation. Be that as it may, the fact remains that nameless Bombay merchants, and phantom ships full of merchandise, have been conjured up, and are said to have brought the cholera from India to Damietta direct, without leaving any trace behind them at Suez and Zagazig. “I affirm and I prove that the present epidemic can not have been imported.” In the preface to his report, Dr. Couvidon says he bases his opinion on numerous thoughtful observations made during eighteen years' residence at Port Said.

I have introduced only what Dr. Hunter related concerning hygienic conditions. The facts which he brings to the support of his assertion that cholera could not have been imported into Egypt in 1883 from India because it has been endemic in Egypt since 1865 are simply more or less isolated and rare cases of *cholera nostras*, which Dr. Hunter regards as essentially identical with true Asiatic cholera, and I do not deem it worth while to cumber this report by reproducing them.

An editorial in the London Lancet of January 19, 1884, thus commented on the peculiar views which Hunter advanced concerning the nature of cholera and the origin of the epidemic in Egypt of 1883:

The paper which Surgeon-General Hunter read before the Epidemiological Society on the 9th of January embodied the conclusions at which he had arrived as to the causes of the epidemic of cholera in Egypt in 1883. Dr. Hunter has no hesitation in assuming that cholera is not a contagious disease, and he entirely disbelieves in the existence of anything that can be called a specific cholera germ. These views not only gave a strong tinge to all he had to say about causation, but they also appeared to have had a marked influence on the character of the investigation which he had carried out. Indeed, after dealing with the question of importation, simply to show that under the circumstances which existed in Egypt no such source of origin can be entertained, he stated that, being one of those who do not believe in the contagiousness of cholera, and who, therefore, did not look for a specific entity or germ, or for its importation into a country, in order to account for the development and spread of the disease, he had turned his attention to the country itself in his search for a cause of the epidemic outbreak. This sentence, which we have reproduced as accurately as possible, will be regarded by many as embodying a confession that the inquiry was approached with a very strong bias adverse to the views which are very generally entertained in this country as to the etiology of cholera, and it will require a strong array of facts capable of standing the test of the closest criticism, in order to remove this impression.

J. A. S. Grant Bey, M. D., of Cairo, communicated to the Albany Medical Annals the following report on the cholera epidemic in Egypt in 1883:

An epidemic of true cholera, such as is prevalent in India, broke out suddenly at Damietta on June 22, 1883. This was verified by a commission of medical men sent by the government to Damietta on June 24. I was a member of that commission. The disease spread rapidly from town to town, following the tracks of communication, more markedly, however, by river and railway. An attempt was made to confine the disease to the different towns where it appeared, partly by isolating the towns infected and partly by isolating individual houses. Under the pressing circumstances of the case, whatever measures were decided on had to be carried out quickly; hence, no doubt, some inconvenience was experienced by those confined within the *cordons sanitaires*, because the whole machinery of communication was suddenly thrown out of order, and it took some time before arrangements could be made for passing food, etc., through the *cordons*.

I am not in a position to assert that the *cordon sanitaire* was the proper measure to adopt, because of the impossibility of making it perfect. I would only make this remark, that, in 1865 a cholera epidemic commenced at Alexandria on June 11 and reached Cairo on the 17th of the same month (*i. e.*, after six days). No sanitary measures of any kind were then adopted, and at the end of the epidemic 61,000 deaths were registered from cholera alone. This time the epidemic commenced at Damietta on June 22, but it did not reach Cairo till July 15 (*i. e.*, after twenty-three days), although Alexandria and Damietta may well be compared together as being in daily railway communication with Cairo. The conclusion to be drawn from this is that even imperfect *cordons* retard the progress of the malady, thus giving time for other towns to make sanitary preparations for the approaching disease.

Notwithstanding, however, the amount of energy displayed in burning down the filthy quarters of towns, in establishing *cordons sanitaires*, in the free use of disinfectants, and in



employing extra English and Indian experience, the sum total of the deaths from cholera during the epidemic amounts to upwards of 56,000.

It follows from this that everything in the country was more or less upset for nearly two months, with the result of obtaining a mortality of 4,000 less than the epidemic of 1865, when trade was not in any way interfered with by sanitary measures. This is a scientific victory, but a gain at a fearful cost to the state. Probably before another epidemic of this kind occurs methods of stamping out the disease will be discovered that will permit of free intercourse between infected and non-infected places without endangering the public health. In the mean time, however, science can not be blamed for suggesting measures that ought to be successful (if properly executed), even in an unsanitary and half-civilized country, while an epidemic is raging; and, in such a country, the measures to be adopted to prevent the spread of an epidemic must necessarily be different from those that are perfectly applicable to a country in a good sanitary condition. Who would stand near and, unconcernedly, allow a lighted torch to be applied to, or even brought into close proximity to, a mound of gunpowder? Of course one may say, "If the near approach of the torch can not be prevented, why not remove the powder? Is it an impossibility?" Well, to remove it *en masse* is quite impossible, and there is no denying that as long as any of it remains there is danger of an explosion. While it is being cleared away, therefore, measures must also be put into execution for extinguishing every spark that may come within reach of the explosive matter.

If the measures of the much-maligned sanitary board had been executed by the government that retains the executive in its own hands, I do not hesitate to say that the last epidemic spark would have fallen comparatively harmless on clean and well-ordered towns and villages of Egypt. As it so happens, however, it has fallen on nothing but explosive material, which is in overabundance throughout the length and breadth of the land. The different routes followed by this epidemic clearly prove that the germ of the disease, whatever the nature of it may be, is not carried by the wind as a living, active agent, else we should have had the malady invading Cairo long before it made its appearance there, for the wind was steadily, day by day, blowing directly from Damietta towards Cairo. We find, however, that before the malady reached Cairo it had gone as far east as Port Said and as far west as Alexandria; and it actually broke out at Geezek before it came to Cairo, and at Siout before it showed itself at Benisouef. This militates against the lines of communication, and especially the railway, which transfers infected persons and things in a remarkably short space of time from one district to another. The important question, therefore, comes to be whether some sanitary measure might not be carried out successfully that would permit of the running of trains as usual without being prejudicial to the public health. I have hinted above that such measures have already been submitted, from time to time, for the approval of the government by the sanitary board, but, whether approved or not, the government has not carried them into effect.

There can not be the shadow of a doubt that the cholera was brought to Boulaq from an infected district, for in my medical register there is rather a decrease than an increase of the diseases allied to cholera up to July 15, when the epidemic manifested itself in Cairo and Boulaq, and the death-rate from general diseases was also lower than the death-rate of the previous year at the same time. This, I understand, was also true of Damietta up to June 22, when the cholera suddenly declared itself there, clearly proving that wherever the malady came from originally, it was certainly imported into Damietta, a town that proves to be the rendezvous of thousands of Arab firemen, whose sole business is to get employed on steamers sailing between Port Said and India, and who, whether there be a quarantine or not, on their return voyage are allowed to go on shore, or do so by stealth at No. 3 Kilometer Station, which is in direct communication with Damietta by ferry-boats.

A good example of the transmissibility of the disease by human intercourse, and of the immunity of a town from a second attack during the course of the same epidemic, is furnished by the following narrative: Several native merchants from a town called Codiya, in the Siout district, Upper Egypt, about 360 miles from Alexandria, spent fifteen days in Alexandria on



business while there were still some cases of cholera there, but long after the epidemic had ceased in other parts of the country. Their voyage home was by boat, and it occupied about sixteen days. On the way they touched at many of the towns, and one of their number who had died of cholera on board the boat was buried at a village named Fuah. But not till they reached Codiya (a village that had, up till then, escaped the cholera) did the germ they brought with them find a congenial virgin soil for propagating itself, when a slight epidemic raged there for several days and then died out.

My railway medical registers,\* being very accurately kept, have proved to be of considerable value in deciding for the non-endemicity of cholera in Egypt.

The following is a table extracted from the medical register of Egyptian railways and telegraphs, extending from January 1, 1878, to October 31, 1883, Cairo division, about 3,000 employés, nearly 2,000 of whom are engaged at the railway works, Boulaq, and for the most part live at Boulaq. They are all of the male sex, and above puberty. The other 1,000 are distributed over Lower Egypt.

*Condensed table from January, 1878, to October 31, 1883.*

Years.	Diarrhea.	Dysentery.	Typhoid.	Dengue.	Cholérine.	Cholera.	Total number of patients.
1878.....	15	30	7	.....	2	.....	794
1879.....	19	34	7	.....	.....	.....	1,169
1880.....	19	43	6	336	.....	.....	1,462
1881.....	9	31	5	146	.....	.....	873
1882.....	11	54	18	97	1	.....	985
1883.....	24	31	27	218	.....	68	1,192

In the above table, extending over nearly six years, there are 97 cases of diarrhea and 223 cases of dysentery, amongst 6,475 patients, but not one of these is registered as *fatal*; on the contrary, they all average only a few days off duty. It must, however, be noted that all these cases are, as a rule, uncomplicated, the most serious complications in any case being hemorrhoids. When diarrhea or dysentery has set in as a secondary and fatal symptom, the cause of death has been registered under the primary disease. Hence, in abscess of the liver terminating by a fatal dysentery, or in phthisis ending by a fatal diarrhea, the cause of death is assigned to abscess of the liver or to phthisis, as the case may be. The ordinary uncomplicated diarrheas and dysenteries amongst the grown up population of Egypt can not therefore be considered very fatal.

From January 1, 1878, to July 15, 1883, a period of five years and a half, there were only 3 cases registered as cholérine (*i. e.*, purging and vomiting with cramps) amongst 6,000 sick employés, most of whom, being of the lowest class, would be the first to be affected by any endemic disease. Two of these cases happened at Boulaq in August, 1878. Both were Arabs, and the one was unfit for duty for four days, while the other was off duty only one day. The third case was a French driver, not, however, at Cairo, but at Alexandria. He was ill only a few hours, and resumed duty after two days.

There having been only two cases of cholérine at Boulaq in 1878, and no more cases there (having a similar nature) till July 15, 1883, when epidemic cholera broke out, affords sufficient proof that cholera is *not endemic* in Egypt.

Gaffky† thus described the sanitary condition of Port Said, Ismalia, and Suez, and the presence of cholera there in 1883:

When Suez was attacked by cholera in 1859 she had only 5,000 inhabitants, and Port Said and Ismalia were barren wastes of sand.

\* Dr. Grant Bey was senior surgeon to the administration of railways, telegraphs, and port of Alexandria.

† Report on cholera by the German cholera commission, 1887, loc. cit.

The greatest difficulty with which Suez, as well as Port Said and Ismalia, had originally to contend was a supply of fresh water. This was somewhat lightened when in 1863 the Ismalia Canal reached Ismalia and was extended to Suez, and a pipe was laid from Ismailia to Port Said, thus securing a sufficient supply of fresh water, and opening the way for their unhampered development which in 1869 followed the opening of the Suez Canal. At the time of the outbreak of the epidemic in 1883 the number of inhabitants in these cities was as follows:

Description.	Port Said.	Ismalia.	Suez.
Native population.....	11,176	2,393	9,976
Foreign population.....	5,989	943	1,190
Total .....	17,160	3,336	11,166

NOTE.—From Dr. Engel's *Essai de statistique sanitaire de l'Égypte*, 1885; the numbers are based on the census of 1882.

With respect to the character of the Arabic quarter of these cities, a similar state of affairs is to be found in each. Filth and uncleanness in the houses and upon the streets is revolting and is constant among the poor Arabic population.

Latrines are only to be seen in the European houses. The natives dig a pit (or trench) several feet deep, in the courts of their houses, which they cover with wood. These pits become gradually filled; they are at long intervals emptied at night and the contents are removed to the fields outside of the town. Naturally all of the houses have not a court sufficiently large for the existence of such a pit, as the filthy streets indicate.

In Suez the same general conditions hold, although some few houses are furnished with underground drains for the removal of waste water, yet the greatest part of the offal is simply thrown upon the ground. Various inhabitants have pits several meters deep constructed at the back of their houses, and lined with bottomless casks to prevent the sand from caving in. Into these pits the dirty water is conducted; the level of the surface of the fluid contents rises and falls with the tide. A clean state of the soil is, therefore, out of the question in each of the three cities. With respect to the mode of life of the natives, it differs in no respect from that of other Arabic localities.

These three cities suffered from cholera in 1883 in a different degree. Ismalia from the 23d of July to the 14th of August lost 56, or 16.8 per 1,000 of her inhabitants by the disease. Then followed Suez with 53 dead from the 23d of July to the 27th of August, or 4.7 per 1,000 of inhabitants; whilst in Port Said, in spite of the proximity to Damietta and in spite of its location between two infected places, and also in spite of the intercourse imperfectly interrupted by the *cordons*, only 8 persons, or 0.45 per 1,000 of the inhabitants, were carried off by the plague, and this happened between the 27th of June and the 4th of July. The majority of deaths occurred in people who were previously infected in Damietta, so that Port Said itself, notwithstanding repeated introduction of the disease, remained almost immune.

In view of these differences between the three cities, it is interesting that with respect to the mode of water-supply there also exist striking differences, if the Ismalia Canal is taken into consideration. The water of Ismalia is liable to be polluted with human excrement, for the fresh-water-course, after passing very near the Arabic quarter, flows immediately by the city. The Arabic population draws its water directly out of the canal. Furthermore, a number of towns and villages are located along the banks of the canal above Ismalia, for which reason the water can easily become infected and Ismalia be thereby placed under those conditions which in fact are found so common in Egypt.

The fresh water is further conducted as far as Suez. On its long course through the desert only a few small stations of the Suez Canal Company are situated, but large villages, such as are found above Ismalia, are no longer located along its banks. It seems, therefore, that a new infection of the water during its course to Suez is not very probable, and that the latter city is placed under more favorable conditions than is Ismalia. The canal empties into the sea above Suez, and its distance from the latter is considerable. The poor people draw



their water in small quantities directly from the canal, and it is thus exposed to a certain amount of pollution. Many houses in Suez are supplied from the reservoir, which is located directly upon the canal, with unfiltered water conducted through iron pipes, but at a very considerable cost. As in Cairo, so in Suez, small fish come through the pipes. The poorer people are supplied from water-skins on camels and from casks upon small carts. The drinking water of the inhabitants is usually first settled in the large porous jars used throughout the whole of Egypt, the so-called 'sirs,' for it is cloudy and deposits a large quantity of slime.

The supply of Port Said with fresh water is not by an open canal, but through iron pipes from the great water-works of Ismalia. The reservoir in Port Said, the so-called Chateau d'eau, which is filled with this supply, is sufficient for the need of Port Said for three days, and the inhabitants are thus protected from a water famine in case of a break in the pipes. Under these circumstances the contamination of the water supply of Port Said by cholera dejecta is possible only in so far as this may happen in Ismalia. That the infecting material may be still active when it reaches Port Said is, as experiments concerning its nature show, not very probable. It may be remarked in this connection that of the three cities in question Port Said was least affected and Ismalia most affected with cholera, and that this corresponded to the relative danger of infection of the water, which was greatest in Ismalia and least in Port Said.

It may be further mentioned here that also this unfiltered Nile water is supplied to the ships.

We are also indebted to Gaffky\* for the following account of the drainage, water supply, and sanitary condition of Alexandria in his remarks on the cholera in that city:

According to Sanitary Inspector Dr. Schiess, there were 231,396 inhabitants in 1882, of whom 187,703 were Egyptian and 49,693 were European and foreign.

In contrast to the new port, which is inhabited by the foreigners and presents an European appearance, is that portion of the city occupied by the poor Arabic inhabitants, consisting for the most part of collections of dirty, low houses and huts, permeated by narrow, irregular streets.

Here are found many conditions which are in no respect better than those of Damietta.

Of the first quarter (Raz el Tin), in which the vice-regal palace is located, the "Rapport de la commission extraordinaire d'hygiène d'Alexandrie sur des travaux pendant l'épidémie cholérique de 1883 (Caire, 1884)," speaks as follows:

In the interior of the quarter one met at every step and in all directions offal and excrement of divers age and origin. The streets were filled with sweepings and flooded with water which had been used in the houses and thrown from the door or terrace.

Often by the side of some houses of fine appearance one found a net-work of narrow alleys bordered by small dilapidated abodes, and ending in a *cul-de-sac* at the bottom of which one could discover a ruin serving as a depot of sewage and of carcasses of many putrefying animals. The interior of these shanties presents always the same disposition. A long and dark passage covered with humidity leads to an interior court surrounded by a certain number of chambers a few feet square, often with floors below the level of the soil, and receiving air and light only by the door; and in these small chambers are crowded together men, women, and children covered with tatters. In a corner is an open, infected latrine, of which the contents overflow and escape into the middle of the court, where the hosts of the miserable dwelling cook their repast upon a few large stones which project above the nauseating liquid.

A little distance from the wall inclosing the Khedival palace, an Arab village of 7,000 to 8,000 souls is located, which was in a state of indescribable filth and surrounded by sanitary conditions so unfavorable that it seemed that it must form a focus of infection upon the first appearance of the scourge.

The city possesses a system of sewerage. First, there are in the northern part of the city, lying between the old and the new harbor, the remains of an old sewer system, which at the time of the epidemic was found in a very neglected condition. The extent of these sewers,

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\* Loc. cit.



some two hundred years old, according to a report in 1865, of the municipal engineer, Herr Dietrich, was about 11,000 meters linear extent for the city, and about 1,500 meters linear for the suburb Minet el Bassal. But some 3,500 meters only of these still exist. In consequence of the slight elevation of the city above the sea level the water stagnates in the sewers, filters through the extremely defective masonry and spreads in every direction through the sandy soil. Against orders, considerable fecal matter also enters them, so that the subsoil is always flooded with decomposing fluids. According to the executive committee of the extraordinary hygiene commission, "in certain places the pressure of the lower layer of this liquid is so great that it is sufficient to dig an opening at the surface of the ground to obtain immediately a jet of putrid water of a nauseating odor."

Besides these old sewers, there exists a new sewer net-work, whose construction was begun in 1868 for the city and for the suburb of Minet el Bassal in 1870, and which is principally laid in the streets of the European part opposite the new harbor. The total length of these sewers reached in 1883 about 23,500 meters for the city and 6,500 meters for the suburb of Minet el Bassal. They have to contend with the difficulty that there is only a slight fall and that in many localities in the city the layer of earth above the level of infiltrated sea-water is only 1 meter deep. Furthermore, they are faultily constructed and only by piece-meal and are by no means water tight, as the following expression of the "commission d'assainissement de la ville d'Alexandrie" of 1885 shows: "They have been constructed in short, detached sections, as the streets are paved; but the general system suffers from the absence of a well conceived and general rational plan of construction. It must be admitted in a general manner that the ensemble of the net-work is not impermeable, that there is consequently a constant infiltration of of the subsoil of the city thus causing putrid emanations of the most dangerous kinds."

In so far as they are not stagnated in certain sections, the contents of these sewers empty through four outlets into the new harbor. Formerly there was also an outlet in the old harbor, but, at the building of the new quay, this was walled up, another outlet being provided.

Still more objectionable than the provision for the waste water is that for the excrement; the latter, except that which finds its way into the sewers, is received in pits, out of which the contents simply escape into the soil. The commission d'assainissement of 1885 speaks concerning this as follows:

In the visits of the commission to the different quarters of the city to witness the emptying of the pits, it was learned that in certain houses all dejecta from the water-closets were conducted into a simple hole dug into the ground without any masonry walls. The matter which the scavengers removed by hand was very compact and pasty, for all the liquids had escaped into the soil, through which they necessarily arose to the surface to escape in exhalations which render the neighborhood pestiferous. There exist a number of walled pits which, thanks to the fissures in their walls, did not require to be emptied for years; the commission visited some, of which the last emptying was more than four years previous.

The excrement of animals after being dried is used for fuel.

Concerning the water supply of the city the following is to be remarked:

Since the not very numerous streams present in the city commonly furnish unhealthy water, fresh water must be obtained from the Mamudieh Canal, which comes from the Rosetta branch of the Nile and empties into the sea at Alexandria. In former times, according to the common custom in Egypt, the water was taken directly out of the Nile by the water-carriers and brought into the houses. A number of the latter were supplied with cisterns which, at the time of the highest point of the canal water, were filled for the whole year. The number of these cisterns has constantly decreased during the last decade, and was at the time of the epidemic very small indeed. Since the year 1860 the city has had a public water supply. This, originally in the hands of a French company, later under the direction of the Egyptian government, went into the control of an English company in 1879, which in addition to the two original filter tanks built a third, as well as a large reservoir for the filtered water upon the Kom el Dik hill. At the time of the epidemic the work was under the direction of the English engineer Mr. Cornish.

The water is first pumped up out of the Mamudieh Canal into a small open canal in which it flows to the eastern end of the city. From there on it is conducted through a closed conduit to the place of filtering, and after thorough purification is pumped up into the reservoir whence it is distributed through a net-work of mains in the city. The place of filtering consists of three large tanks, of which two are always in action whilst the third is in process of cleaning. The filter bed consists of large stones upon which a layer, about a foot thick, of coarse sand is spread out. Every filter is subdivided by twenty-five perpendicular walls into sections which are in connection with one another in such a manner that the water introduced into one passes through all the sections. Every nine days the filter is cleaned by scraping off the deposit of slime with a superficial layer of the sand, and is again used. At the high point of the Nile, when the canal water contains a large quantity of silt, this cleaning, which always requires three days, must be done at shorter intervals. The reservoir on Kom el Dik is constructed of iron and has a capacity of about 70,000 cubic meters. In winter the city is supplied with 16,000 to 17,000 cubic meters daily, and in summer 21,000 to 22,000 daily. Of a total of about sixteen thousand houses, only some four thousand are connected with the water supply. In the streets there are numerous outlets besides. In ordinary times from only a few of the latter is the water taken without paying; at the time of the epidemic, however, the thirsty were given frequent opportunities to supply themselves with the water free of charge.

The water supplying the above-mentioned tanks for filtration, as well during its course in the Mamudieh Canal as in the small side canals leading to the city, is frequently exposed to pollution, for on both sides of these uncovered water-courses villages and houses are located. But during the epidemic such pollution near the city was wisely prevented by a watch placed over these water courses.

As regards the efficacy of the filter, it could be seen that the dense cloudiness of the canal water was not entirely removed by the filtration. Apparently there was a further purification in the reservoir by settling, for the water taken from the outlets of the pipes in the city no longer showed any cloudiness. An investigation on the 19th of September proved that the water freshly drawn from one of the outlets of the water supply in the Grecian hospital was clear and colorless, and 1 cubic centimeter of it contained only 1,320 germs of micro-organisms capable of development, whilst 1 cubic centimeter of the Mamudieh Canal water taken at the origin of the small side canals leading to the water-works contained 46,000 germs. Furthermore, in the houses of the well-to-do inhabitants the water received from the water supply is customarily subjected a second time to filtration through large porous jars before it is used. An investigation of the water thus freshly filtered showed 120 germs capable of development in 1 cubic centimeter. The water used for drinking in the hotel of the commission contained, according to an investigation on the 20th of September, 2,000 germs to the cubic centimeter.

Gaffky\* also thus described the sewerage, water supply, and sanitary surroundings of Cairo:

The city of Cairo, situated immediately on the eastern branch of the Nile, is bounded on the north by the Ismalia Canal, which, branching off from the Nile at the lower extremity of the city, runs directly east and supplies Ismalia, Port Said, and Suez with Nile water. A smaller canal, the 'Khalig,' leaves the Nile at the upper end of the city and flows through the latter in a northeast direction to unite with the Ismalia Canal.

According to a calculation based upon the census of 1882 by Dr. Engel, the population of Cairo in 1883 was 374,857, of whom 353,207 were native-born.

Like Alexandria, Cairo also possesses a net-work of underground sewers, but in the latter city as little as in the former can a genuine and well-regulated system of sewerage be spoken of. For even in the better quarters most of the houses have pits, from which the fluid contents escape into the dry sand of the subsoil, never needing to be emptied. For example, in the Hotel du Nord, occupied by the commission, there was a deep sink in the middle of the gardens, into which the excrement was conducted. As far back as any one remembered this sink was never

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\* Report of German Cholera Commission, loc. cit.



emptied or cleaned. The sewers are so laid that they have not sufficient fall, and their contents, therefore, stagnate in them. In part they empty into the Nile above the Nile bridge, and also above the inlet to the Ismalia Canal; in part also into the latter; and in part into the Khalig Canal, which flows through the city. Under such circumstances it can not be surprising that at the time of the low point of the Nile the air of the neighborhood becomes pestiferous from the Khalig Canal.

In order to improve this evil influence, not only were 200 cubic meters of burnt lime thrown into the Khalig Canal at the outbreak of the epidemic, but they sought to prevent further pollution by closing up with masonry the mouths of sewers emptying into it. Such measures show the value of the sewerage of Cairo.

The city was in a not less unfortunate plight with regard to her water supply at the outbreak of the epidemic, although many years ago public water-works had been constructed by a private company which since then has enjoyed exclusive rights of management. The water-works lie upon the southern bank of the Ismalia Canal, a few hundred meters east of the inlet from the Nile, and take their water supply in part directly from the Nile itself, close above the bridge Kafr el Nil, in part directly out of the Ismalia Canal. The large intake pipes extend out to near the middle of the bed of the canal, so that the water shall not be taken immediately along the bank. The works consist of four basins, of which two serve to clear the water by depositing the heavier suspended particles, and two others serve for filters. The uppermost layer of the filter-beds consists of very coarse sand. The quantity daily supplied, by the company, of filtered and unfiltered water averages about 22,000 cubic meters, inclusive of the consumption of fifty-one street outlets, of which forty-five should be supplied with filtered and six with unfiltered water. The commission had the opportunity, upon a visit to the works, to witness tests of the water which immediately before had been filtered. It contained all kinds of fibers and coarser particles and showed a distinct opalescence. According to the statements of numerous persons worthy of belief, the water supplied in mid-summer is unusually cloudy and has a bad taste. That it had these qualities also during the epidemic, the commission is assured by Dr. L. Wild and Dr. Almed Hamdy Bey. Besides, certain quarters of the city regularly receive unfiltered water, for the quantity of the filtered water is insufficient.

In the houses of the well-to-do people the water is once again cleared by settling in porous jars.

The above-mentioned bad conditions are intensified in their importance by the fact that the Ismalia Canal, close above the spot from whence the company draws its water, is polluted, not only by the discharge of a number of side canals, but is also used by the Arab inhabitants of Boulaq commonly for bathing and washing of dirty clothing, etc. The Austrian physician, Dr. von Becker, when he visited the first cholera patient in Boulaq, found, where the water-works take their water from the canal, the bank crowded with women who were washing dirty clothing from the infected part of Boulaq. It was only at a later date, when the epidemic had already passed its acme, that the company ordered that the water be no longer drawn from the Ismalia Canal, but exclusively from the Nile. The conditions were, however, not much bettered thereby; for also immediately above the point of intake from the Nile, drains which convey human excrement in large quantities empty into the stream.

Besides the public water supply in Cairo, as all over Egypt, water drawn directly out of the Nile or its canals is used by the poor people. And it often happens that in the immediate vicinity of the spot where the water is obtained, at the same time dirty body clothing is being washed or human dejecta voided into the water, without even the slightest consideration.

Finally, a pretty large number of houses, at least of such as are distant from the Nile or the Ismalia Canal, are furnished with large cisterns, which at the time of the high point of the Nile become filled with water which yields a supply for the whole year.



*Table showing extent and course of the Egyptian cholera epidemic of 1883.\**

Cities and places.	Number of deaths from cholera.	Date of first death from cholera.	Date of last death from cholera.	Remarks.
Damietta .....	1,956	June 22	Aug. 13	Sept. 2, not yet ended.
Port Said .....	8	June 27	July 4	
Mansurah .....	1,075	July 2	Aug. 6	
Samanud .....	352	July 2	July 31	
Alexandria .....	789	July 2	.....	
Cherbin .....	114	July 3	Aug. 2	
Menzaleh .....	258	July 9	Aug. 6	
Talka .....	90	July 10	Aug. 23	
Chibin el Gom .....	1,120	July 11	Aug. 8	
Zifta .....	225	July 11	Aug. 10	
Ghizeh .....	698	July 15	Aug. 10	
Cairo .....	5,664	July 15	Aug. 24	
Mit-Ghamr .....	216	July 16	Aug. 16	
Mahallet el Kebir .....	680	July 16	Aug. 25	
Sinbelanin .....	161	July 18	Aug. 13	
Tantah .....	539	July 19	Aug. 21	
Beni Suef .....	138	July 20	Aug. 15	
Kafr el Zaiyat .....	161	July 20	Aug. 17	
Benha .....	158	July 23	Aug. 22	
Ismalia .....	56	July 23	Aug. 14	
Suez .....	53	July 23	Aug. 27	
Mefiehe .....	4	July 25	Aug. 5	
Menuf .....	115	July 26	Aug. 22	
Minieh-Roda .....	26	July 27	Aug. 9	
Barrage (Cairo) .....	128	July 27	Aug. 13	
Minieh .....	305	July 27	Aug. 23	
Kafr-Dawar .....	27	July 27	Aug. 12	
Zagazig .....	306	July 28	Aug. 21	
Rosetta .....	230	July 28	Aug. 21	
Heluan .....	20	July 28	Aug. 15	
Menufieh .....	2	July 28	July 28	
El Wardan .....	26	July 30	Aug. 16	
Kalyub .....	3	Aug. 2	Aug. 2	
Atfeh .....	81	Aug. 3	Aug. 20	
Girge .....	254	Aug. 4	Sept. 3	
Damanhur .....	275	Aug. 6	Sept. 1	
Dakalieh .....	1,494	July 18	Aug. 30	Sept. 21, not yet ended.
Minieh .....	851	July 25	Sept. 3	
Charkieh .....	1,344	July 19	Aug. 21	
Garbieh .....	1,466	July 14	Aug. 23	
Behera .....	587	July 23	Aug. 31	
Ghizeh .....	750	July 26	Sept. 16	
Kalnubieh .....	585	July 22	Aug. 26	
Beni Suef .....	873	July 26	Sept. 1	
Menufieh .....	438	July 21	Aug. 16	
Assiout .....	1,342	July 31	.....	
Kene .....	404	Aug. 3	.....	
Girge .....	1,558	Aug. 6	Sept. 7	Sept. 21, not yet ended.
Fayum .....	416	Aug. 6	Aug. 31	
Esne .....	10	Sept. 6	.....	
Total .....	28,442	July 22	.....	Sept. 21, not yet ended.

The foregoing abstracts from various sources relating to the outbreak of cholera in Egypt in June of 1883, and to the precursors and accompaniments of the invasion of that country, contain several noteworthy points which I think should be emphasized.

In the first place, this Egyptian epidemic of cholera in 1883 at last occurred after the danger had for some time hung over that country. In this there was nothing new or unusual, for the history of former visitations of cholera is full of instances where a threatened country

\* Report of German Cholera Commission, loc. cit.

commonly, and sometimes even repeatedly, receives ample warning of its danger. It seems certain that the epidemic of cholera in Egypt in 1883 was preceded by the presence of the disease in Arabia in epidemic form among the Mohammedan pilgrims at Mecca, in 1881 and 1882; that these outbreaks at Mecca were each time preceded by the presence of cholera among Mohammedan pilgrims en route from India to Jeddah (the Red Sea port for the Holy City); that previously the disease actually became epidemic at various places (notably at Aden) en route between Bombay and Jeddah; and that cholera was epidemic in the presidency and city of Bombay and other parts of India whence the pilgrims came or through which they passed, both at the time of and prior to embarkation at Bombay for the port of Mecca.

In the second place, it appears equally certain that cholera followed and preyed upon the Egyptian pilgrims returning from Mecca both by land and by sea in 1881, but did not advance toward Egypt farther than the quarantine stations of El Tor, El Wedj, and Moses Wells, established in the route of westward-bound pilgrim ships and caravans; that the epidemic also dogged the steps of the homeward-bound Egyptian pilgrims in 1882, but fortunately did not pursue them into the desert farther than Medina, the quarantine stations en route of El Tor, El Wedj, and Moses Wells, not being reached that year.

In the third place, it is certain that the sanitary inspection at the port of Aden, a British coaling station on the southern coast of Arabia, by the British officials of the pilgrim ships from India to Jeddah, was so careless or perfunctory or unskillful, in 1881 and 1882, that the presence of cholera on board any ship at the time of its arrival in that port, or during its westward passage thereto, was not thereby revealed, notwithstanding the fact that the disease was certainly on board at least one such pilgrim ship in each of those years.

In the fourth place, it is very evident that the presence of cholera on westward-bound pilgrim ships was at least once in each of the said years, systematically and intentionally, not to say fraudulently, concealed by the ship's officers through falsification of entries in the ship's log relative to the sanitary condition during the voyage. Such notes of the causes of death during the voyage from Bombay, where cholera prevailed at the time of departure, as "exhaustion," "colic," "senile marasmus (*in a victim aged only thirty-five years*)," and the like are capable of but one interpretation under the circumstances, especially where the ship's surgeons were East Indian medical officers of no slight experience with Asiatic cholera. (Consult also in this connection Koch's account of the systematic concealment of the presence of cholera on board the "*Crocodile*," a homeward-bound British Government transport ship from India, loaded with returning Indian troops and their families, Chap. VII of this report.) Expressed in the plain language which the seriousness of possible consequences fully justifies, such sanitary records made under such circumstances indicate strongly that in these instances there was a conscienceless conspiracy to suppress the real truth, for commercial and other advantages. In this connection it is also noteworthy as affording a possible clue to the explanation of the origin of the Egyptian epidemic of cholera in 1883, that, according to the statement of Dr. Grant Bey, No. 3 Kilometer Station of the Suez Canal is in direct communication by ferry-boat with Damietta, the point of outbreak of that epidemic, whilst this city is largely inhabited by firemen (stokers) who rendezvous at Port Said for employment on steamers plying between the latter place and India; and that it is not uncommon for these Damietta stokers to quietly leave the westward-bound steamers at this station, in order to escape the sanitary inspection at Port Said and a possible detention there in quarantine.

In the fifth place, it is notable that Egypt escaped a cholera invasion in 1881, although she was then seriously threatened through cholera-stricken pilgrims returning from Mecca, both by land and by sea, and it is highly possible that she was saved by an efficient Red Sea and caravan quarantine service, which was enforced not alone for her protection but also for that of Europe. Again in 1882 she was jeopardized, but less seriously, for the disease did not this time extend northward in the Red Sea beyond Jeddah, or into the Arabian Desert farther than Medina.

In the sixth place, although it has been extremely difficult to absolutely trace the outbreak of cholera at Damietta, in June of 1883, to direct introduction from India, there can be no



reasonable doubt that such was its origin. The purely gratuitous assumption that the cholera was and had been for a long time epidemic in Egypt—a theory advanced by Sir W. G. Hunter and a few others more or less closely associated with the administration of British interests in Egypt or India—is not only totally without any warrant of fact, but is in direct conflict with all respectable evidence, and with the knowledge of the march of cholera outside of India.

Lastly, the evidence is entirely harmonious that at the time of the prevalence of cholera in Egypt in 1883 the whole country was in the worst possible hygienic condition. Filth and abominations of every description abounded everywhere, and the drinking-water and milk supply were with rare exceptions grossly contaminated with excrement and other revolting substances, while the soil beneath and surrounding the dwellings reeked with the vilest affluvia. In truth, whatever may have been the origin of the epidemic, all agree that the seeds of the disease found a soil excellently prepared for rapidly yielding a rich and abundant harvest of death. After the epidemic had existed for some days, during the continuance of a fair at which upwards of ten thousand visitors from neighboring and more or less distant towns were in Damietta, and after many of them had dispersed to their scattered homes, the attempt was made to cordon the city, under the delusive hope of thereby confining the disease within its limits. The failure of this effort to restrain cholera by the use of cordons sanitaires has been frequently pointed to as another of the many examples of the utter failure of this means of opposing the march of an epidemic of Asiatic cholera.

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## SECTION 2.

### INTRODUCTION AND SPREAD OF CHOLERA IN FRANCE.

About the end of June, 1884, it was announced that an outbreak of cholera had taken place in Toulon, the great naval entrepôt of France upon the Mediterranean, and soon afterward a similar announcement was made of the appearance of the disease in the neighboring city of Marseilles. The infection was alleged to have been brought from China to Toulon in a transport vessel, the *Sarthe*, whose commander was reported to have committed suicide owing to mental distress caused by his relation to the disaster. Drs. Brouardel and Proust, however, who were deputed by the French Government to investigate the matter, reported to the French Academy of Medicine that no blame could be attached to that unfortunate vessel, and that the first case of cholera occurred at Toulon June 14, and the second on the following day, on board the *Montebello*, a ship that had been lying in port for fifteen months.

According to the official report on the cholera epidemic of 1884, in the department of Bouches-du-Rhône, presented by MM. Rampail, Villard, Nicolas-Duranty, and Quelrel, "the total deaths from cholera in 1884 have been, for the whole department, 2,397. Deducting the 1,792 deaths in Marseilles, the 112 in Aix, and the 198 in Arles, there remain 295 deaths distributed unequally among the small communes of the three arrondissements.

Accompanying this report is a map of the department on which all of those communes which have suffered deaths from cholera are marked; they number 58 or 59, inclusive of the Salins de Giraud.

"In these fifty-eight communes, twelve had only a single case; six of them 2 cases, and seven of them 3 cases. But eleven of them had more than 10. The most severely attacked in the arrondissement of Marseilles were, Auriol, Aubagne, and Roquevaire; in that of Aix, Martigues, and Saint-Cannat; and in that of Arles, Saint-Remy, Saint-Andiol, Eyragues, and Châteaurenard. Tarascon had a very limited and intense focus (25 cases and 15 deaths).

"Thoroughly as we have studied the meteorological tables, not only of this year but of the past year, and of those in which we have had epidemics, we have been unable to perceive a correlation between the temperature, the atmospheric pressure, or the altitude of the localities, and the cholera mortality. Neither have we been able to determine the law of advance

in the invasion of the communes, although at first glance it seemed to us that the cholera followed the valleys of the Huveaune, of the Arc, of the Touloubre, and finally of the Durance. If it is true that, along these water-courses, localities have been more especially attacked, we hasten to declare that this has not been by following the course of the stream downward. Finally, notwithstanding we believe we have observed that, in those places where disinfection had been practiced in an intelligent manner, the scourge seemed to be checked, we are obliged to say that sometimes it was so, in the first instance, without recourse to these hygienic measures. This, however, is not a reason for neglecting them, especially in crowded places."

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*ABSTRACTS OF CONSULAR REPORTS ON THE ORIGIN AND CHARACTER OF CHOLERA IN MARSEILLES AND ToulON, 1884, 1885.\**

THE ORIGIN AND NATURE OF THE CHOLERA AT ToulON AND MARSEILLES.

Upon this point there has been a hot and acrimonious dispute since the first case appeared at Toulon on the 22d of June. Although this dispute is not yet officially settled the actual facts are sufficiently plain.

On the one hand, the mayor of Toulon, who would be naturally held responsible for the neglected sanitary condition of that city, has insisted from the first that the disease which appeared there two weeks ago † is genuine contagious Asiatic cholera, imported by a supplemental Government transport which had been employed in the expedition to Tonquin, and having had cholera on board at Saigon, returned to Toulon and was admitted to port by the naval authorities and placed in dock for repairs.

On the other hand, the chief medical officers of the French Government, supported generally by the official journals and the medical authorities of the navy, have pronounced the disease merely sporadic cholera, due to the filthy condition of Toulon and the neglect of ordinary sanitary measures there. This opinion was sustained generally during the first week of the epidemic by the commercial press of Southern France, which naturally sought to allay excitement and avert the disastrous commercial results of a cholera panic.

Between these two extremes there has been brought forward, after some delay, the verdict of the board of physicians sent by the French Government to Toulon, upon the first announcement of the outbreak, to diagnose the malady and dictate measures of resistance to its progress.

These gentlemen visited the hospitals, the suspected troop-ship, and the most infected quarters of Toulon; they made examinations of the dead victims of cholera and were at first disposed to pronounce the disease sporadic, the element of contagion being for a time notably wanting. But on the 27th a young officer of marines returning to Toulon after leave of absence, was attacked within a day of his resumption of duty and died after a few hours of terrible agony, his case presenting all the marked features of true Asiatic cholera. On the same day a student from the Lycée of Toulon, who had returned several days before to his home in Marseilles, was seized with Asiatic cholera at the latter city, and died after an illness of eight hours which defied all remedies.

On the day following (23d) a custom-house official employed at the Quai du Canal in Marseilles was brought home at 2 o'clock in a critical state and died at 6 o'clock the same evening—a clear and indisputable case of Asiatic cholera. Meanwhile there were under treatment at Toulon about 30 cases of cholera, of which all but six or eight were pronounced mild, and the deaths there from choleraic causes had at no time since the first outbreak exceeded 8 per day. With these facts in view the Government physicians returned to Paris, and on the 30th of June presented their verdict, which probably stated accurately the then real truth, viz, that the real contagious Asiatic malady existed at Toulon and Marseilles, but that a large proportion of the cases were of a mild type and presented only the recognized features of sporadic cholera.

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\*Abstracts of reports of U. S. Consul,

† Report of United States Consul, July 7, 1884.



The real danger was present. It had appeared in the first month of summer, six days later than the first outbreak of the terrible visitation of 1865, and it became a question of how far vigorous and intelligent sanitary measures could prevail against an epidemic which had become so early and so thoroughly established. This contest is still in progress, and it is the purpose of this (consular) report to note briefly some of its more important features.

Both Marseilles and Toulon suffered terribly in the cholera epidemic of 1865. During the nineteen years which have elapsed since then, Marseilles has been in several important respects almost rebuilt. Her pavements, her sewerage system, her water supply and method of cleaning the streets, removing night-soil, inspecting and regulating the food markets, her quarantine regulations and hospital facilities, are all probably unsurpassed in excellence by those of any large maritime European or American city. The old quarter of the city, the ancient Marseilles, which was scourged so sharply by the plague in former centuries, has been pierced with broad avenues; streams of fresh water flow down the gutters of the narrower streets and alleys, and the pavements of the principal thoroughfares are washed and swept with much care and frequency.\*

The terrible lesson of former epidemics has been well learned by the municipal government, and long before the first rumor of trouble at Toulon, Marseilles was cleansed and made ready for the summer heats. But with all the intelligent liberality which the city has evinced in the construction of her drainage system, there is an insurmountable difficulty which all Mediterranean cities are alike compelled to face—their sewers flow into a tideless and generally placid sea.

The harbor of Marseilles is almost entirely artificial. The old port is simply the estuary of a small creek, dredged out into a large dock, with a narrow outlet to the sea. The new ports are spacious harbors, inclosed by miles of pier and breakwater, and deepened into navigable depth by dredging and excavations. Into these inclosed ports, which extend along two-thirds of the shore front of the city, the entire volume of sewage is poured, and as there is only the surplus fresh water of the city hydrants to dilute this turbid flow, and as there is no tide to maintain a circulation of sea water through the inclosed ports, the inevitable result is that the latter grow foul and pestilent.

The same conditions, unmitigated by equally vigorous sanitary measures, prevailed at Toulon, and it was thought by some that the dredging of a disused dock there, during the months of April and May, developed the seeds of the present epidemic.

On the other hand—and this is but one of the many curiously contradictory features of this perplexing subject—it is asserted that the old port of Marseilles, the main cess-pool of its sewage, was almost entirely exempt from cholera during the epidemic of 1865, but one death having occurred on all the shipping there assembled, and that was of a sailor who came on board his ship at midnight and lay exposed to the damps and cold until morning. But however this seeming paradox may have been in 1865, the Marseilles government of to-day relies solely upon the most rigid and searching enforcement of recognized sanitary measures.

The dredging of the ports has been stopped, and that source of miasma, as far as possible, abated during the summer. Since the outbreak at Toulon the whole city has been literally washed with water and disinfectants, not once merely, but daily and nightly. The markets are carefully inspected, and immense quantities of stale and unripe fruit and vegetables seized and destroyed. Railway cars, stations, omnibuses, street cars, even hackney carriages, are fumigated and disinfected, and the smell of chlorine, sulphates, carbolic acid, is everywhere. Chateau Pharo, the imperial palace built by Napoleon III, upon a promontory in front of the city, has been converted into a hospital where all choleraic cases can be isolated and treated. An ambulance corps has been organized, which patrols all quarters of the city, to provide immediate transportation for the stricken to this spacious and airy asylum. Industrial guilds and civic associations have offered their permanent services to the city government to perform, under official direction, the most dangerous and menial services that may be required in treating the epidemic.

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\* Later reports from this consulate show this high praise of sanitary condition of Marseilles and Toulon undeserved. (See pp. 51, 52, 53, 55, 56, et seq.)

Simultaneously with the two virulent cases of Asiatic cholera at Marseilles already noted, there began a period of intense, sultry heat, which with the exception of the 30th, when a cooling *mistral* blew over the sweltering city, yet continues unabated. On the evening of the 28th of June this stifling heat was accompanied by dense swarms of mosquitoes, which settled upon the lower part of the city, and were only driven off by fires of pitch and rosin which were lighted along the streets during the night. It was remembered that a similar visitation, accompanied by a dead, stifling atmosphere, had marked the beginning of the great epidemic of 1865, and this circumstance, added to the steady increase of the disease at both Toulon and Marseilles, produced on Saturday night and Sunday a panic which continued until the Tuesday following. During this period many thousands of people removed to suburban residences or the interior of France. Many pathetic and distressing incidents have occurred during this sudden and precipitate exodus, but, in general, the deportment of people of all classes has been courageous and admirable.

It is now something more than a week since the first two deaths from genuine Asiatic cholera occurred at Marseilles. For several days after those cases the death rate remained so small and the daily number of new cases so stationary that it was hoped and believed that the vigorous sanitary measures which had been taken would restrict the outbreak in this city to a limited area, and in a short time suppress it altogether. But the intense, sultry heat which began on the 28th of June continued throughout the following week; swarms of fugitives from Toulon continued to pour daily into the city, without restriction or disinfection, and on Saturday and Sunday, the 5th and 6th of July, both Marseilles and Toulon found that the epidemic had escaped control, and realized that the worst that had been feared had come.

The record of choleraic deaths on those two days, the last whose statistics are included in this report, were 13 and 16, respectively, at Toulon, and 11 and 15 at Marseilles. Several of the deaths occurred in the cleanest and handsomest portions of Marseilles. So that the fact is only too apparent that the Asiatic cholera brought hither from Toulon, 40 miles distant, has been distributed and taken root throughout this city.

The cholera epidemic of 1865 began on the 16th of June, and for six weeks underwent a period of incubation, the deaths previous to the 1st of August ranging from only 1 to 5 per day. On the 21st of August they had risen to 30 per day, and on the 16th of September the death-rate attained its maximum, 63. From that time it gradually subsided until the disease disappeared in the following December. It thus appears that the attack of the cholera has been this year far more vigorous and fatal than it was in the great epidemic of nineteen years ago; the pestilence is here and defies restraint.

#### RECAPITULATION.

The present situation\* may be, therefore, summarized as follows:

I. The epidemic which now prevails at Marseilles and Toulon is Asiatic cholera, imported beyond all reasonable doubt, from Saigon, China, by the French transport *Sarthe* to the port of Toulon. At first the disease was of the type medically classified as "benign;" but its malignity has since increased by its further diffusion and development under the influence of continued hot weather. At Toulon the epidemic has spread in some degree to neighboring villages, and from Marseilles it has penetrated as far toward the interior as Aix in Provence.

II. The sea-going commerce of Marseilles is, for the time, almost entirely suspended. Italy, Spain, Tunis, and Algiers impose quarantines of from seven to fifteen days upon all vessels from these two infected ports. Ottoman ports absolutely refuse entry to such vessels upon any and all conditions. A strict quarantine of seven days has been established on the land frontiers of Italy and Spain against all persons coming from France, and the conditions of these frontier quarantines in respect to baggage and merchandise are daily becoming more rigid and exacting.

Under these hopeless conditions, nearly all the steam-ship lines between Marseilles and other Mediterranean and eastern ports have suspended operations, and have or will soon close their offices in Marseilles.

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\* July 7, 1884.



On the French island of Corsica no vessel from Toulon or Marseilles is permitted to land passengers, baggage, or merchandise.

III. In Lyons, and at the Paris terminus of the Paris, Lyons and Mediterranean Railway, all passengers, baggage, and freights, as well as cars, coming from Marseilles, are fumigated disinfected, and subjected to the strictest surveillance.

*PROGRESS OF THE EPIDEMIC IN MARSEILLES.\**

The following table gives the number of deaths from choleraic disease which have been recorded in Marseilles on each day from the outbreak of the epidemic on the 26th of June until the evening of the 18th of August, viz:

Date.	Deaths.	Date.	Deaths.	Date.	Deaths.
June 26.....	2	July 14.....	70	Aug. 1.....	26
27.....	4	15.....	60	2.....	16
28.....	2	16.....	58	3.....	15
29.....	4	17.....	56	4.....	23
30.....	4	18.....	53	5.....	10
July 1.....	5	19.....	65	6.....	11
2.....	3	20.....	57	7.....	5
3.....	2	21.....	61	8.....	18
4.....	6	22.....	57	9.....	11
5.....	11	23.....	44	10.....	14
6.....	15	24.....	48	11.....	15
7.....	19	25.....	38	12.....	11
8.....	23	26.....	53	12.....	12
9.....	33	27.....	36	14.....	20
10.....	59	28.....	24	15.....	15
11.....	70	29.....	23	16.....	14
12.....	65	30.....	24	17.....	16
13.....	61	3.....	12	18.....	14

This shows a total of 1,492 deaths, or an average of nearly 28 per day for the whole period.

It will be noted that on one day (the 7th of August) the death-list declined to 5, and rose gradually to 20 on the 14th of the same month. This notable decrease on the 7th instant was due largely to favorable weather and the very effective arrangements which had been perfected for feeding the unemployed poor. The increased death-rate during the week following was ascribed almost wholly to the precipitate return to the city of a large number of fugitives, who, after having lived an uncertain and more or less irregular life for a month or more, returned despite the earnest and repeated warnings of the press, the medical and civic authorities, and re-occupied their badly ventilated and infected homes.

THE RESULTS OF HOSPITAL TREATMENT.

At the beginning of the epidemic the vacant Imperial Château Pharo was converted into a special hospital for the treatment of cholera patients. Its location, though central, is on a promontory near the entrance to the old and new ports, and being exposed to the fresh sea-breezes is as favorable as could be desired.

The building is surrounded by a large park, its spacious salons and corridors had long been vacant, it was free from contagion, and admirably adapted for the purposes of a special hospital. It is served by a corps of devoted nuns, trained to hospital duties, and its medical staff has included some of the ablest physicians in the city. With all these circumstances in its favor, the Pharo has achieved the following record from the 26th of June until the 4th of

\* Report of United States Consul, August 19, 1884.

August, the latter date being the latest to which the official record is now accessible: Total number of choleraic cases admitted, 503; remaining under treatment, 61; discharged as cured, 166; died, 276.

Deducting from the whole number of cases admitted those remaining under treatment at the date of the report from which these figures are condensed, it appears that out of 442 patients 166 were cured and 276 died, a death-rate of 62.4 per cent., which is 10 per cent. higher than the death-rate under similar conditions during the epidemic of 1865.

The proportion of deaths to cases in the city at large, that is, the cases treated at the homes of the patients, can probably never be accurately ascertained, as in many instances persons who were cured of cholera at their own residences have been reported as having been ill with fever or other non-contagious diseases. But the death-rate by "arrondissements," which ranges from 0.62 per 1,000 inhabitants in the quarter of the Palace of Justice to  $5\frac{5}{6}$  per 1,000 in the old, densely built quarter of the Hôtel Dieu, shows conclusively that it is the slums of a city, the narrow, noisome streets lined by swarming tenements, that the Asiatic scourge mainly attacks. In some of the cleaner, wealthier portions of the city subscriptions have been raised for the purpose of igniting large fires at evening along the principal thoroughfares, and much of the immunity of certain handsome streets is ascribed to this precaution, though with what justice it would be difficult to say.

Great stress is laid by many persons, including some physicians, upon the fact that a great conflagration at Constantinople some years ago put an end to a cholera epidemic even in quarters which were untouched by the fire, but it is difficult to account for this upon any scientific theory as more than a coincidence.

#### CHOLERA IN MARSEILLES DURING 1883.

Although the fact has not been officially announced, it is now learned upon authority which seems unquestionable that the cholera which prevailed in Egypt during the summer of 1883 was imported to Marseilles and caused a number of deaths.

During the month of July, 1883, the total deaths in this city from intestinal diseases was 253, as compared with 157 for the same month of the preceding year, and this increase probably represents very accurately the number of deaths from choleraic disease. The malady was, however, of a comparatively benign type, and soon yielded to skillful treatment. By a discreet collusion between the mayor, two hospital physicians, and several Sisters of Charity, who acted as nurses, the nature of the disease was concealed, and a cholera panic, with all its deplorable effects upon commerce and general business, was averted. There is no reason to doubt that every possible precaution in respect to isolation of the choleraic patients in the main hospital, burial of the dead and disinfection of their bedding and effects, was thoroughly enforced, and if this preliminary touch of the epidemic had any substantial effect it was to suggest the active sanitary measures which were enforced in Marseilles early this summer, and which brought the city to such a complete state of preparation prior to the malady of Toulon.

#### THE SPREAD OF THE EPIDEMIC IN SOUTHERN FRANCE.

By the middle of August, 1884, cholera had spread widely throughout the whole district within a radius of 100 to 150 miles from Marseilles. At Arles, Aix, and Cette, as in this city, the disease seems to have spent its first malignant energy, and the death-rate in those places is either stationary or slowly declining. At other places, notably in various small villages in the departments of Ardèche, Hérault, and Basses-Alpes, it has broken out within a week past with fatal intensity. Among the most striking cases of this class is that of the village of Omergues, 25 miles from Sisteron, in the department of Basses-Alpes. The place is a small, closely built mountain hamlet of 700 people, having no physician or apothecary, and few ideas of cleanliness or sanitary prudence. About ten days ago a servant from Marseilles returned to her family at Omergues, bringing the fatal germ of contagion. She and two other members



of her family died; the corpses were left for a day or more unburied, panic seized the little community, and before the facts became known and help could be sent from Sisteron, 25 of the poor creatures had died. The prefect of the department hastened to the scene, physicians and medicines were brought, and the epidemic at that point was checked, although it still prevails there in a very fatal form.

In many cases the contagion is preserved and spread by that most willful and criminal stupidity which prompts these thrifty peasants to preserve and sell the bedding and clothes of their dead relatives. These, with that other large contingent, whom no danger or warning can prevent from excessive indulgence in melons, stale fruits, and cold drinks, have been in this as in past epidemics mainly instrumental in keeping alive and transmitting the pestilence.

There seems to be, however, some definite suggestion in the capricious, irregular spread of the cholera throughout Southern France this summer, passing by certain villages to attack others in the same neighborhood, and increasing or diminishing under certain conditions of moisture, winds, and temperature.

A careful study of all attainable facts of this kind would seem to show that the ignition and spread of cholera in a community are favored by four fundamental conditions, viz:

(1) Porosity of the soil, which would allow choleraic dejections to penetrate to sufficient depth to reach springs, wells, or other sources or channels of water used for domestic purposes. Open, gravelly soils are therefore the worst in this respect.

(2) The facilities offered by drains, sewers, and water-courses for the circulation of infected water under and among the dwellings of a village or city.

(3) The accumulation of fecal or other decaying organic matter infected by choleraic dejections.

(4) Close, crowded, ill-ventilated dwellings, combined with unwholesome and irregular alimentation and neglect of cleanliness.

All this has, of course, long been known, but it is worthy of record that during the spread of the present epidemic the towns and villages of Southern France have been stricken in very exact proportion to the degree in which they involve one or more of the above conditions.

What is called "caprice" or waywardness of Asiatic cholera is simply its persistence in seeking conditions favorable to its propagation and diffusion.

But it is essential that the real facts of the present situation should be neither underestimated nor misunderstood.

The harbor of Marseilles, as was explained in a previous report, covers nearly the entire water front of the city, and has but three narrow outlets to the open sea. Into these inclosures of tideless water the sewers pour the filth and dejections of the entire city, nearly every part of which is at present more or less contaminated by cholera.

Poisoned thus by a constant influx of sewage, stagnating and festering under the sultry heats of midsummer, the waters of the port of Marseilles have become putrid and pestilent. Any vessel which is moored for even a day in the harbor, or any freight that may be landed or taken on board under such conditions, may become infected to a degree which may involve future danger, but which no present inspection can detect.

The authorities of Marseilles have done the utmost that zeal, courage, and intelligent liberality could do to stamp out the present cholera epidemic on shore. The officers and people of this city have set a shining example of what may be done by human energy and wisdom to stay the ravages of cholera. The efforts have succeeded, under Providence, in notably diminishing the spread and fatality of the disease. But the power of such remedies stops with the shore. Until some system of subaqueous conduits is devised to carry the ceaseless flood of sewage farther out to sea, it is difficult to see how more can be done than has been done to modify the fetid condition of the harbor.

The port of Cette, though in better condition than that of Marseilles, is likewise infected with cholera.

*THE SANITARY CONDITION OF TOULON AND MARSEILLES, 1885.*

## TOULON.

The port of Toulon, the principal naval and military station of France on the Mediterranean, has a population of about 70,000, including a large contingent of sailors, soldiers, and workmen in the extensive arsenal and dock-yards which have long been established there.

The city proper is old and closely built. Some of the tenement buildings fronting on narrow and crooked streets are six and seven stories in height, and swarming with a dense and generally untidy population. The place is, in fact, a fortress, protected against modern weapons and tactics by forts crowning the neighboring hills, but retaining still the heavy encircling parapet wall and ditch, which greatly restrain the natural expansion of the city. The densely built quarter adjacent to the docks is on low and almost level ground, and on either side of the main port are moored rows of old, rotting wooden hulks, the frigates of half a century ago, which are now used as barracks, store-ships, and hospitals.

The city has no underground sewers, but rivulets of water flow down the open gutters, into which are poured daily the night-soil and other filth of the population, except such as is still more unfortunately thrown into open cess-pools in back yards and areas, which become in summer nests of infection. For many years it has been the practice to throw vegetable and other garbage into the new dock near the arsenal, and as that portion of the harbor is under control of the national Government, the city authorities are unable to suppress this dangerous practice. It is this confusion of responsibility and conflict of authority between the national and local governments which has hitherto been a most serious obstacle to the sanitary improvement of Toulon. The ministry at Paris is unwilling and the city authorities unable to undertake the radical and costly improvements which alone can make Toulon other than what it has been for generations, a breeding place for disease, a hot-bed for the quick propagation of every epidemic that may come from Africa, the Levant, or the pestilent ports of Asia.

An earnest and eloquent appeal, addressed recently by the mayor and council of Toulon to the central ministry, sets forth eight radical and important measures to be undertaken at national expense which are essential to the sanitary improvement of the town.

Among these are the entire demolition and reconstruction of certain old and densely built quarters, opening various streets and avenues through the fortification wall, cutting a wide canal between the old and new ports to create a possible current and change of water in the harbors, the removal of the present lazaret or quarantine hospitals to the island of Hyères, or elsewhere, at a safe distance from the city, and to repave the streets of the city entire, removing the substratum of earth, which is soaked and poisoned with the filth of centuries. Besides this there is needed a sufficient water supply to furnish the city and environs for culinary and other purposes, so that the use of water from wells and cisterns may be prohibited for all purposes except washing and irrigation. These recommendations were urgently presented to the ministry in September last, but up to this time almost nothing has been done.

Some change is being made in the water-works, which, when finished, is expected to increase the supply, but the present effect is to diminish even the ordinary scant supply of water during the important months of March and April, when it is of the highest importance to cleanse the city thoroughly before the advent of summer heats.

There are several open ditches in and about Toulon which have no water except during the infrequent rains of this region, and not sufficient grade or fall to cause a healthy current even then.

These ditches are open sinks of pollution, and there is a strong demand by the health authorities that they, like the cess-pools in private premises, shall be closed. The discouraging fact is that the sanitary defects of Toulon are so radical and so numerous that their reform would not only require years of labor, but involve an outlay of money which neither the city nor the General Government is prepared to meet. Certain parts of the town would need to be entirely demolished and rebuilt, and a company has been formed to undertake a small part of this work, but their enterprise is only a beginning of what needs to be done. The old harbor



is choked with the accumulated filth and garbage of many years, but it is a question whether the dredging of this foulness at this time would not increase rather than diminish the immediate danger. During the epidemic of last year the expenses of the city were unusually heavy, and the deficit thereby created now restricts seriously the power of the municipality to preserve even ordinary cleanliness.

The net result is that while a great deal has been said and printed, many remedies proposed and suggested, very little has been actually done at Toulon, and the city will, from all present appearances, drift along toward midsummer in a condition quite as exposed to epidemic influences as that of a year ago, with this danger still further increased by the dormant germs of cholera which were left by the scourge of 1884.

It is generally conceded that filth alone does not *create* cholera; if it could, Toulon would breed an epidemic every summer; but surface sewage, noisome, narrow streets, and a polluted harbor certainly offer a ready and fertile hot-bed for the propagation of the malady, and it must be admitted, however regretfully, that the present condition of Toulon suggests far more of warning than assurance.

#### MARSEILLES.

As has been stated previously, the city of Marseilles is, in respect to sanitary improvements, much more advanced than Toulon. Originally the two cities were similarly defective in construction, and suffered equally from the plague in the Middle Ages and from the successive visitations of cholera which have occurred during the present century.

But thirty years ago the city of Marseilles constructed a canal 60 miles in length, which brings the water of the river Durance in profuse and never-failing abundance, so that the wells and cisterns which formerly furnished the people with water have long been disused. The Durance is an Alpine stream, whose waters are strongly colored with a slaty detritus, and like other rivers it brings down also the drainage of the villages and farms along its course. But along the canal large ponds or reservoirs have been constructed, in which the water is allowed to stand and settle, so that it reaches the city in a fairly pure and limpid condition. That a city like Marseilles, in a country so arid and so nearly rainless as Southern France, should thus enjoy an abundant supply of even ordinary water is a highly creditable and satisfactory result. The sewers throughout a large part of the city are admirably constructed, and the pavements are probably as good as those of any European city. In the general scheme of improvements that was worked out twenty years ago, broad streets were cut through the most crowded and unhealthy portions of the old town; and the arrangements for street cleaning and removal of night-soil and garbage, although in some respects defective, are fairly efficient. Some of the older buildings are destitute of proper accommodations, and the lower classes of people have generally the lax ideas of Southern Europe in respect to culinary and personal neatness.

But, like Toulon and most other Mediterranean cities, Marseilles finds in its harbor a source of impregnable difficulty and more or less constant danger. There is in the nature of the case no outlet for the sewage of the city but the sea, and as almost the entire water front of Marseilles is lined with wharves and inclosed by sea-walls, these artificial harbors become great cess-pools, which the Mediterranean, having neither tides nor permanent currents, fails to purify. The filth that is poured from any of the numerous sewers stinks and festers until it is removed, that is to say, the more solid portion of it, by dredging. During the epidemic of last year the dredging was suspended for sanitary reasons, but during the past winter it has been actively resumed, and the harbors will be this summer in no worse than their usual condition. Various plans have been suggested to obviate this peril by cutting a subterranean canal along the entire city front to gather and discharge the sewage at a point several miles down the coast, or by laying large iron pipes under the harbor and through the breakwater from each sewer to the open sea, but these would be laborious and expensive measures, and nothing has been decided upon or begun.

The epidemic of last year was a costly experience to Marseilles, and the sanitary fund was largely overdrawn. There is at present\* a sharp controversy in the municipal council over the

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\*Report of United States Consul, March 24, 1885.

question whether a large part of this money was not injudiciously spent for costly and useless disinfectants. There is a general complaint that not only are certain quarters of the city more dirty and neglected than they were a year ago, but that a large part of the people, instead of being warned and stimulated by the severe lesson of 1884, have relapsed into the lethargy which so often follows a danger past, and are more than usually careless and unclean. The local press is filled with protests and appeals on this subject, but the best that can be hoped is that Marseilles will be nearly as clean and ready as it was last June, when the cholera appeared at Toulon and so quickly developed itself here.

The epidemic of last year killed only 1,734 people in Marseilles, and as the 80,000 or 100,000 fugitives who then left the city have returned, it is assumed that the ready material here—in other words, the percentage of persons with choleraic tendencies—is not yet exhausted. The history of previous epidemics teaches that, particularly in cities which, like this, are rarely visited by frost, the dregs of one year's pestilence may most likely become the seeds of a new outbreak, and that Asiatic cholera once established in Europe continues its march with a persistence that baffles conjecture and for a time defies restraint.

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*THE TRUTH ABOUT MARSEILLES; HOW THE CHOLERA ORIGINATED; THE PRESENT SITUATION, AND PROSPECTS OF THE EPIDEMIC (1885).\**

It was inevitable that an early and rude awakening should follow the ignorant delusions which the city authorities of Marseilles sought to cultivate by the rigid suppression of all sanitary data during the early days of the present epidemic, and by repeated declarations that the health of the city and neighborhood was satisfactory.

The shock came on the 14th instant through the simultaneous publication in the local newspapers of two remarkable documents, the special report of Dr. Brouardel to the National Academy of Medicine, and the Monthly Sanitary Bulletin, edited by Dr. Albénois, a prominent physician of this city, who is officially charged with the collation and the publication of the vital statistics of Marseilles.

Dr. Brouardel, the widely-known Government expert on contagious diseases and epidemics, had, as was reported in a previous dispatch of this series, accompanied M. Legrand, minister of commerce, on his inspection at Marseilles on the 4th and 5th of August. Upon returning to Paris, the eminent doctor presented before the Academy of Medicine at its session on the 11th of August a report which stripped away the disguises and evasions behind which the mayor of Marseilles had sought to conceal the growing epidemic, and revealed the ghastly truth that the city was in the first stage of an epidemic of real Asiatic cholera which had not been imported from Spain or elsewhere, but propagated here in our midst by the filth and neglect of Marseilles impregnated by the surviving germs of last year's visitation. A single quotation from the report of Dr. Brouardel will show how clearly he states the important facts which underlie the present situation. Speaking of Marseilles, "it must be declared," he says, "that even the most elementary principles of sanitary cleanliness are unknown there. The gutters of the streets flow with the veriest filth. The canals and the sewers, many of which are open, are infected. On the eastern side of the Old Port is one building which contains 700 inhabitants, whose excrements are thrown into recesses on the stairways, forming in some places a mass of 2 cubic meters. Behind the mayoralty is a school for young girls, poisoned by exhalations from the vaults of neighboring closets, and aired only by windows opening upon a dark, closed court, which is a veritable sink."

Having fairly declared that the epidemic of this summer has been kindled in the same houses and streets which were most severely stricken last year, Dr. Brouardel attributes the responsibility for this squalor to the imperfect law of 1850, under which proprietors are enabled to evade legal sanitary regulations concerning closets and drainage. He moved a demand that this law be amended, and the motion was unanimously affirmed. Had this

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\* Report of United States Consul, August 19, 1885.



startling report been unsustained by other testimony, it would probably have been discredited as a hasty verdict of a Parisian savant, presumably prejudiced against Marseilles. But, on the day of its publication here, there appears in the same journals a still more damaging disclosure by Dr. Albénois, whom the people of this city have learned to respect as the highest legal authority on sanitary science. Having stated frankly that 44 deaths from Asiatic cholera had occurred here during the last days of July, 5 of which had taken place upon as many vessels moored separately in the Old Port, and that the others originated in certain houses which were severely visited last summer, Dr. Albénois says: "In most cases these houses are notoriously unclean, some actually infectious, especially those in the rear of the Bourse. In narrow, noisome streets, deprived of air and light, where there still prevails the old system of *passares*, which is to-day simply the throwing of all excreta out of the windows, a process which is perfected in some instances by a conduit surmounted by a funnel placed beneath the window, and while it may in some degree prevent the passers by from being splashed, nevertheless leaves the whole mass of putrescent matter in the street below. We have not ceased to urge for years that it is these same wretched quarters that have continued to carefully nourish the germs of all contagious and infectious maladies. We have demonstrated that by abolishing them it is possible to save each year the lives of at least 1,500 persons." After describing and denouncing the system of sewers which, with one exception, pour the entire filth of the city into the Old Port; the open drains, like the Garret and the Hauveaune, which spread death along their course; and having explained how in one notorious instance the contractor building a cross-sewer was permitted to block up the tributary ones until the filth which they carried backed up and submerged the cellars of adjoining districts, whose inhabitants were left unadvised of the cause of this stoppage, Dr. Albénois concludes that "it is certain that if it had been desired to prepare the ground for a new epidemic it would have been impossible to adopt a more effective process." These brief quotations from official documents of unquestionable authority will explain sufficiently the causes of the reigning epidemic, and indicate the errors and neglects to be avoided by other municipalities.

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#### CHOLERA IN THE FRENCH PYRENNEES.\*

During the recent severe epidemic in Spain the French Government has hitherto maintained a line of sanitary pickets or posts of inspection along the Spanish frontier. These posts were generally under charge of young physicians, or medical graduates, who, under competent direction, become very efficient and maintain an effective surveillance over passengers and merchandise over all roads and railways connecting the two countries, without imposing needless restrictions upon freedom of communication; but as the surveillance in Spain subsided with the advancing autumn, these sanitary sentinels were either withdrawn or relaxed their vigilance; so that by the end of October communication across the frontier was practically uninterrupted.

It is thought to have been more or less due to this relaxed vigilance that cholera appeared on the 2d of November at Prades, a town of 4,000 inhabitants in the department of Pyrénées-Orientales, 25 miles from the Spanish border, and about the same distance from the sea. The disease showed no abatement in malignity by reason of the cold weather, and many cases proved fatal in four or five hours. On the 16th there were 5 deaths from cholera at Prades, and the malady had spread to the neighboring villages of Device, Eus, Touring, and Nahides. About the same date it appeared also at Perpignan, the capital of the department, which is situated near the sea and on the railway from Cette to Barcelona.

It is impossible at present to give the exact results of this outbreak. It appears, however, that from the 2d to the 20th of November there were 25 deaths at Prades and about as many more in the neighboring villages. At Perpignan the disease was less fatal (a fact due

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\* Report of United States Consul, November 25, 1885.

perhaps in some degree to better medicinal treatment), and in general the intensity of its attacks has gradually declined as the weather became more cold and damp from the November rains.

It is thought by the medical authorities of the infected district that the epidemic will not extend beyond its present limits or develop in serious fatality this season, but the facts herein reported are worthy of record as illustrating the erratic nature of the disease, and showing the danger that still lurks in the whole Mediterranean region adjacent to the recently stricken provinces of Spain and France. Prades and Perpignan had been almost in the presence of cholera during the entire summer, but they escaped infection until the scourge had become extinguished at Marseilles, and was so nearly so in Spain that the usual safeguards had been abandoned.

This recent outbreak in the Pyrénées-Orientales is but a small item in the general epidemic account of this year. But it exemplifies the persistent malignity of cholera under conditions not usually considered favorable to its development, and is a significant warning of what may, unfortunately, recur with the advent of another summer.

In a letter accompanying his dispatch of January 7, 1886, to the Department, the consul at Marseilles, in apologizing for his tardiness in forwarding information concerning small-pox, states that "if it may seem to the Department strange that these facts should not have been earlier reported, I beg to explain that since October all mortality statistics have been suppressed or withheld from publication by the municipal authorities, and clean bills of health have been issued by the public health officer to all outgoing vessels since the 23d of that month, as heretofore reported."

The above-mentioned dispatch relates to the sanitary condition at Marseilles, a part of which is introduced here: The vital statistics of Marseilles for 1885 form a gloomy and unpromising record. The total death-list of the city included 12,352 persons, of whom 114 perished by suicide, 119 by accident, 33 by murder. The cholera, which in 1884 had totally disappeared on the 29th of October, persisted in 1885 until past the beginning of winter. Although this port was officially declared clean from epidemic on the 23d of October, and clean bills of health have since been issued by the health authorities to outgoing vessels, there were, as now appears, 13 deaths from cholera in Marseilles during October, and 2 in December (on the 3d and 9th respectively), since which date it seems to have definitely disappeared. But this is not all; during the past three months the small-pox, which in Marseilles as in most all other large cities nearly always prevails in some degree, has gradually assumed more serious proportions until now it is fairly epidemic in several of the older quarters of the city. Thus, during the year 1884, 19 deaths were registered, whilst in the year 1885, during the same period, from July to December, there were 292 deaths from this disease.

Under the French law, which prohibits physicians from reporting publicly the nature of any disease from which a patient has died, and which places all sanitary and mortuary records under the absolute control of local authorities, it is impossible to ascertain the precise number of cases of small-pox which have occurred here during the above period.

The Official Sanitary Bulletin for November was withheld by the authorities from publication because it disclosed the 13 deaths from cholera during that month; and, as the statistics for December have not yet been published, it is only by chance or common rumor that the growing fatality of small-pox has become known outside of official municipal circles. The public press is still silent on the entire subject, and no steps have been taken to enforce vaccination in the public schools or among the people.

It is an ungracious duty to record this further misfortune to a city whose commercial interests have been so recently and disastrously stricken by recurring pestilence; but the truth is too plain to be distorted, and too serious to be ignored. The underlying facts of the present sanitary condition of Marseilles can not well be more concisely or plainly stated than in the words of Dr. Albénois, the official vital statistician of this city:

'If,' says Dr. Albénois, 'we compare the present with the corresponding period of last year, there appears reason for painful surprise. In 1884 the invasion of cholera, although



more grave than in 1885, had totally ceased on the 29th of October. After that date there existed in our city, so to speak, no form of contagious disease. These excellent results, as we have hitherto demonstrated, were the direct effects of the energetic measures of cleansing and disinfection which were adopted at the commencement of the cholera.

'The expenses of these measures, legitimate in the highest sense, have been rudely and ignorantly criticised by certain nefarious persons who are always ready to oppose their ignorance and nonentity to any really useful and necessary improvement. Unfortunately, their complaints have been listened to, and the municipality, thus constrained to attempt some trifling economies, has had to be niggardly in its measures for disinfecting and cleansing the city during the recent epidemic.

'We do not hesitate to ascribe distinctly to these causes the desperate persistence of the cholera epidemic of 1885, and the extraordinary totals which we now disclose of deaths from contagious and infectious diseases. It is indeed evident that the municipal treasury is richer by some thousands of francs; but how much have the people of Marseilles lost and have yet to lose when we declare the ghastly record of mortality at the close of the year. Moreover, she is counting for nothing the immense losses which are inflicted upon commerce by the reputation of Marseilles as a city perpetually infected, and always a menace to the rest of France and the whole world. There is nothing surprising in the present prostration of business and the misery of our people, and we leave the heavy responsibility of these misfortunes to those who pretend that questions of popular amusements, for instance, are more important than those of public health.'

This stinging arraignment by the highest official authority of Marseilles seems to be based upon facts and statistics which are impregnable and conclusive. The health of cities depends directly on their cleanliness and sanitary arrangement. The cholera outbreak here in June, 1884, caused an extraordinary and thorough cleansing and disinfection of all the great cities of Europe. The result was that in Paris, for example, the death-rate fell from its natural average of 26.46 per thousand during the previous ten years to 18.50 per thousand in 1884. In London, where the sanitary measures were most thorough, the death-rate was reduced to the extraordinary figure of 15.40 to each one thousand of its population; while at Marseilles the rate for the same year ranged from 30 to 50, with a maximum of 50 deaths for every one thousand inhabitants in certain arrondissements of the city.

And now, after all this experience, it remains to be said that thus far nothing has apparently been done for the permanent sanitary improvement of this city. During the epidemic of last summer a credit of 300,000 francs was voted by the General Government to be used in building a lateral sewer, or otherwise improving the drainage system of Marseilles under plans to be approved by the minister of the interior. Thus far nothing has been agreed upon, and the only precautionary measure now in force is the suspension of dredging in the docks; so that at the mouths of certain sewers the discharged sediment has filled up to the surface of the water. Any adequate change of the present sewer system which makes a cess-pool of this busy port would be a long and costly task, and it begins to appear inevitable that Marseilles must drift on towards another summer with every sanitary provision as defective and vulnerable as during the past two gloomy years.

In a dispatch, April 8, 1886, the consul at Marseilles shows by comparison of mortuary statistics the then serious condition of public health in that city, and quotes a published legal statement of the causes of such condition, and reviews the serious aspect of cholera in France, Italy, Spain, and other countries as indications of future danger. It appears that in January of 1886 there was an excess of 495 deaths over those of the corresponding period of the previous year; while in February there was a like excess of 656 deaths; and in March a similar excess of 670 deaths. And if this mortality were to continue throughout the year in the same ratio, it would give for the year 1886 a death-rate of 48 per thousand inhabitants.

An analysis of the facts shown by the detailed statistics explains this excess in part by demonstrating the existence of serious epidemics of small-pox and diphtheria, and a striking increase in the number of cases of typhoid fever as well as scarlet fever and measles. A para-

graph abstracted from a leading local journal indicates the causes of this increased infection of Marseilles:

'The unhealthiness of the city,' says Petit Provençal, of this date, 'has for its principal causes the use of cess-pools and tinettes [open metallic boxes or receivers in closets] for the reception of all fecal and other putrescent matter produced by the population. Whatever may have been the date of their construction, most buildings are devoid of proper drainage. The throwing of all excreta into the streets continues in a great many quarters, including the suburbs. How can it be otherwise, the landlords, wishing to save expense, often providing stingily those famous zinc tinettes, the contents of which exhale such pestilential odors? During the cholera epidemic we have received numerous complaints from tenants who were forbidden to use those often very scanty tinettes, on pain of having their rent increased.'

In a dispatch from Marseilles, May 1, 1886, the consul incloses a copy of a public petition of the people of that city setting forth the condition of the city and the obvious reasons therefor as follows:

"We ask that regulations be enforced to prohibit the use of tinettes, or movable receivers, and in a general way of all and any device letting into the street and gutter fecal matter even when much diluted in water, such being the recognized vehicles of contagious diseases. In a word, we are in a most strenuous way opposed to the principle of 'all into the sewer,' or 'all into the street.' For two years past this community has been suffering from all kinds of epidemics. It is time that the municipal council should at last arrive at such decisions as will afford us protection against all the calamities which have overwhelmed us in these years, and the origin of which can be laid to the revolting filthiness of our streets."

#### *A CHOLERA EPIDEMIC IN FINISTÈRE, 1885-6.\**

Cholera appeared at Concarneau September 18, 1885; it ended February 2, 1886. There were 35 deaths in a population of 5,191.

At Guilvinec it appeared October 1 and ceased December 24; deaths 71, population 1,968.

At Audièrne it began October 25 and lasted to January 15. Among 1,700 inhabitants there were 420 cases of cholera and 144 deaths.

At Kerhuon it lasted from the 27th of October to the 30th of November. Among 1,242 inhabitants there were 15 deaths.

At Brest, from the 3d of November to the 1st of February (day of the last death), there were 39 deaths (11 in November, 13 in December, 14 in January, and 1 on the 1st of February).

At Douarnenez the disease commenced the 13th of November and is not yet (Feb. 9, 1886) completely extinguished. There were still upon the 5th of February 6 cases, and upon the morning of the 6th, the day of our visit, 1 patient died. In a population of 9,809 there were 65 deaths.

At Quimper the first case was observed on the 27th of November. The last death took place the 30th of January. During the time of our sojourn at Quimper I did not see a single case. In a population of 15,000 souls there were 35 deaths from cholera.

At Ile de Sein, from the 4th of December to the 24th of January, there were 24 deaths in a population of 792.

Finally at Plougastel, a village of Tindulf, there were in a single house 3 cases terminated by death the 14th and 15th of December.

#### ORIGIN OF THE EPIDEMIC.

*Concarneau*.—The disease in Finistère began at Concarneau, and it appeared to have been imported there by tunny-fishermen coming from Spain. The first case occurred the 18th of September in one of the suburbs of the town at Lin, upon the road from Pont-Aven. The day after, another case made its appearance upon the road from Quimper. Up to this time

\*By M. Proust, Bulletin de l'Académie de Médecine, No. 6, February 9, 1886.



there had been in the town no diarrhoea or any symptom indicating general intestinal disturbances. After four or five days several new cases appeared in several new quarters, in neighboring houses; and in less than a week cases appeared in a pretty large number, all remaining limited within the quarters originally attacked. Towards the 18th of October the cholera extended, and the adjoining communes of Beuzec-Conq and of Lanriec were invaded, but Dr. Galgain remarked that during the whole epidemic the principal foci were located at the two points originally attacked and also in the inclosed town, surrounded by ramparts, where the poor population dwelt in unhealthy habitations.

*Guilvinec*.—The first case of cholera appeared at Guilvinec on the 21st of September and the first death took place the 1st of October. To the village of Kerity-Penmarch the cholera was imported from Concarneau, as also to the small neighboring fishing port of Saint-Guénolé, where two men attacked at sea were set ashore from a Concarneau boat and transported to the hospital of Pont-l'Abbé, where they died a short time after their arrival. The cholera spread very little in these places, and from there reached Guilvinec, which was only slightly distant from one of them. We should note that the first case which resulted fatally at Kerity had eaten and drank the evening before in an inn at Concarneau, two or three hours distant by boat. Cholera had already existed at Concarneau for several days.

*Audièrne*.—The sanitary condition of Audièrne was very good, when towards the end of October fifty fishing boats came into its port for refuge. These boats came from Guilvinec, where cholera was raging at that time. It should be added that the force of these boats comprised a number of people attacked with cholera or diarrhoea. Eight or ten of them came in order to receive attention from Dr. Hébert, who observed on the 26th of October a grave case of cholera in a patient aged thirty-five years. This man had been in communication with the fishermen of Guilvinec. He died the 30th of October. One of his relatives, a working-woman of forty years, who had attended him, was attacked and died on the 31st. The 3d of November a little girl of three years, who dwelt in the same room with this woman, died. On the 6th, a laboring woman of forty years, who had attended this little girl, died. All these persons dwelt in the Guervilen quarter. At present (February 9, 1886) cases of cholera are appearing in this part of the town.

*Douarnenez*.—The cholera epidemic which ravaged Douarnenez commenced the 9th of November, and the first death took place the 13th of November. The cholera was brought by fishermen.

The 9th of November a fisherman arrived sick from Guilvinec, where the cholera already prevailed, and died on the 13th of November. The next day, the 10th, a boat sailed by three men returned to Douarnenez from Guilvinec. Two of these men at the time of their arrival were evidently suffering from cholera. Both were taken to the quarter Pen-au-hoat, where the first patient was already. From this time cases successively appeared in this quarter.

The 27th of November other cases occurred in the quarter Staukon. The first two victims were relatives who had attended the three first patients of Pen-au-hoat.

About the 26th of November the epidemic reached the quarter Portrhu, in daily communication with the quarters of Pen-au-hoat and Staukon, and about a hundred meters distant. These three quarters were inhabited by fishermen. The quarter of Portrhu adjoins the west of the town which was attacked after these first three quarters.

*Quimper*.—The first case of cholera observed at Quimper was that of the woman Dahoulas, attacked the 27th of November. This woman, about thirty-five years of age, sold a peculiar kind of bread known as "sweet bread" to the inhabitants of Quimper, and in particular to the peasants of the neighboring villages where she went from time to time. Fifteen days before the commencement of her attack she had gone to Pont-Croix, in the neighborhood of which several cases of cholera existed at that time. We should remark that Quimper, the head of the department, had frequent communication with all the fishing ports attacked with cholera before the 27th of November, the date of the invasion of Quimper. For all the other localities in the interior there existed only infrequent communication with these same ports, and it was only in a few of these localities that one met with refugees coming there to die with cholera. In none of them did a focus form.

The disease commenced therefore at Concarneau the 18th of September; it appeared afterwards at Guilvinec the 30th, and at Audièrne towards the end of October, the 26th; at Douarnenez the 9th, and at Quimper the 27th of November.

#### FACTS RELATING TO TRANSMISSION.

The investigation which we made established in many cases transmission in the same house and in houses of the same street. Receptivity was favored by the following causes: Dirtiness, poor and insufficient food, intemperate habits of laborers and sailors, unhealthiness of too narrow rooms with confined and vitiated air. Transmission was favored by the following causes: Want of precaution and of care in guarding against contagion, crowding of individuals in the same room where the patients were, late burials, and large numbers of people who came to see the corpses and remained near them.

*Audièrne*.—The first patient, named Kervarec, was cared for by his mother-in-law. The latter took the disease and died. The third victim was a grand-child who lived in the same house as the mother-in-law.

*Douarnenez*.—First, a woman took the straw from the bed of a dead cholera patient, brought it to her house and used it for littering her cow. This woman contracted cholera and died. Second, the wife of a dead cholera patient removed to her sister's during the disinfection of her house. She fell sick and died. Third, the sister contracted the disease and also died.

*Quimper*.—At No. 18 Douarnenez street, a cholera patient was attended by a woman from Kerfeunteun, a commune near Quimper. This woman fell ill; she was brought to her home (commune de Kerfeunteun). There she was attended by one of her aunts, who in her turn was attacked by the disease and went home to die.

At No. 21, same street, a patient died of cholera. The mother who attended him took home linen soiled by the dejections after having refused to allow it to be disinfected. She died of cholera three days after her son.

In a house a man addicted to alcohol died of cholera; his daughter-in-law who attended him succumbed three days later to the same disease. The father, mother-in-law, and the husband of this woman attended her during the three days of her attack; they hardly ever left her; they ate in the same chamber. All three took the cholera; the husband and mother-in-law survive, the father died. Two young girls who from time to time came to see the patient during these three days, but who had never eaten in the apartment, did not contract the disease. By the investigations which we have made officially of the physicians and sisters of charity, it is established that of four sisters of charity who attended the sick, and who took personal precautions, such as eating outside the sick-chamber, washing their hands, etc., only one was attacked and she recovered; whilst many members of families who spent their time in the care of the sick or remained near them without taking any precaution were attacked and died.

#### INFLUENCES OF BAD HYGIENIC CONDITIONS.

At Quimper all the sick belonged to the poorer class. There were no cases among the troops. The same was observed at Brest where there were 6,000 men in garrison, and at Concarneau where there was a company. The custom-house officers were equally free from attack. In all the places attacked the victims almost invariably belonged to the very poor class. The greater number were addicted to drink. Very rare cases were met with among persons well-to-do, and of the latter almost all survived.

#### INFLUENCES OF SOIL.

The soil of the towns and villages attacked by the cholera, as elsewhere in Bretagne, is generally composed of an impermeable layer, most frequently of granite. This layer is found at very little depth—1 to 3 meters below the surface at Quimper, 1 meter at Guilvinec,



a half meter at Lechiagat. Above this layer is the organic soil, forming a covering of varying thickness. Between this organic soil and the granite, sand everywhere exists, especially at Guilvinec. The surface of the soil is most commonly very muddy. Pools of water are very numerous because of lack of drainage. At Poulgoazec, in particular, the most important street of the town received, besides rain-water, all that which escaped from numerous dung-hills placed at the side of the houses, and from numerous pig-sties located along the street. We should remark besides that ordinarily the fecal matter is thrown into the streets. If one has in view the bad condition of surface drainage, the organic products of all sorts which are deposited upon the surface, if one takes account also of the permeability of the superficial layers (such as turf and sand) and of the small depth of the impermeable layer, one can comprehend how the wells of these localities are exposed to infiltrations.

#### PART PLAYED BY WATER.

*Guilvinec.*—Almost all the villages use for drinking water that which is furnished by a reservoir called a fountain, situated in the center of the quarter Palus—a reservoir which is only a well—and by other wells situated at different points. This water comes from filtration through the superficial layers. The turf and the sand form a layer of only 1 meter at most above the impermeable granite. This water is, therefore, contaminated by every sort of organic matter, fecal as well as other, which covers the soil in profusion, and at the time of the epidemic also by choleraic material, which latter was never thrown upon the beach, and which even when it was disinfected was buried near the houses at a depth of 50 to 60 centimeters. It is to be remarked that in two or three houses where cistern-water was made use of no case of cholera was observed. But that which is still more interesting is the fact that near Guilvinec small villages built upon the rock were entirely free from the epidemic. In one of them there were two imported cases, but the disease did not spread. A most striking example, moreover, is that furnished by what happened at the village of Lechiagat, separated from Guilvinec by a narrow arm of the sea, which is uncovered at low tide. In 1886 this village did not have cholera, while Guilvinec was invaded. During this year it served as a place of refuge for numbers of the inhabitants of Guilvinec, and the disease did not spread there. Now, it is to be remarked that the inhabitants of this town drink water of an irreproachable source which they bring from a distance of 2 kilometers. Sometimes they drink rain-water, but never well-water. This village has always been free from epidemics, whilst small-pox, typhoid fever, and cholera have raged at different times in Guilvinec.

*Quimper.*—At Quimper the water supply is of two different kinds. A part of the town uses spring-water which is brought from a distance by means of closed pipes or canals. Other parts are supplied by well-water. It is to be noted that it was only in those quarters exclusively using well-water that cholera appeared. One of those wells, the water of which contained organic matter as shown by analysis, was closed; but another adjoining one, receiving its water from the same subterranean source, remained open because it belonged to a private individual, and the inhabitants of the quarter continued to use water from this well.

*Douarnenez.*—The greater part of the town of Douarnenez receives its water from a spring situated outside of the town, and which is conducted to the town by means of trenches in a perfect condition. The suburbs are supplied by well-water, particularly the quarters of Pen-au-hoat, Stankou and Portrhu, which were most attacked. At Stankou especially the wells were not closed and were below the level of the streets of that quarter. At the time we were in Douarnenez a few cases of cholera which still existed were in the part of the town which used the spring-water brought in the pipes.

*Audièrne.*—Audièrne is supplied by two springs, both situated outside the town. One of these springs is inclosed and the water is furnished by canals and supplied to that part of the town first attacked. The second was not closed at the commencement of the epidemic and is still open. The quarter which it supplies was attacked only towards the middle of the epidemic. We should add that a certain number of the inhabitants possessed private fountains which do not appear to have played any rôle.

*Concarneau.*—The water supply is exclusively from a spring situated 2 or 3 kilometers outside the town, and the water-courses are in a good condition. The water here does not appear to us to have played any rôle in the propagation of the epidemic.

#### DWELLINGS.

The floor of the rooms most frequently is formed by the ground. Upon this floor mud and pools of water are sometimes found. The inhabitants sleep in beds in the form of a bureau, often superimposed, and frequently they sleep five or six in a room. The windows are very narrow and usually can not be opened. Often also the ground floor is below the level of the streets, and the entrance of the house is badly protected against the influx of water and of putrid matter from the street. One of the houses which we saw at Concarneau appears to us especially poor. This house consists of one room; the floor is of damp earth upon which there were straw, pools of water, and excrement. It was occupied by a woman of forty-five years, proprietress of the dwelling. She had just had cholera and was herself couched upon a bed without mattress, clothing, or covering, and furnished only with a little straw, although some days before covering, clothing, etc., had been given her. A very narrow alley led to this house. In this habitation neither furniture of any sort nor cooking utensils were to be seen. The physician and the mayor, who accompanied us on this visit, said, however, that it was difficult to recognize this dwelling, it had been so improved and cleaned up. Formerly this room was greatly crowded. At Poulgoazec we saw on the ground floor, in the same room, very small, and furnished with a single small window, two large bureau beds, wet nets and a great amount of fishing tackle, carrots scattered around the floor, and masses of soiled linen. This chamber was the sole room where three adult persons and five children lived. Before the house, the ground floor of which is below the level of the street, is found a mass of dung, the dripping from which can easily enter the interior of the dwelling. Behind the house is a pig-sty.

We would add that at Audièrne a large number of the houses were located upon a small hill, and moisture covered the walls of the dwellings.

#### SEWERAGE.

The most of the houses have no water-closets. The excrement is ordinarily thrown upon the dung heaps near the houses or into the street. Rarely the inhabitants carry it to the sea. At Quimper, in a certain number of houses, a kind of cask exists in which one empties every morning the fecal matter. These casks are then removed by the peasants, who spread the matter upon the fields. At Douarnenez one meets with these same casks. During the greater part of the epidemic the peasants were unwilling to come to remove them and it was necessary to throw their contents into the sea. At Concarneau these casks also are to be found, but they are not numerous and are defective. They are not known at Guilvinec or at Audièrne. We would add that at Douarnenez the mayor is actively pursuing the construction of permanent ditches.

#### CONCLUSIONS.

*First.*—The importation of cholera at Concarneau and at Quimper is probable; it is absolutely proven at Guilvinec, Audièrne, and Douarnenez.

*Second.*—In none of these places did there exist before the appearance of cholera any so-called premonitory intestinal disturbances. The physicians of Concarneau, Guilvinec, Audièrne, and Douarnenez are very positive upon this point. They even remarked that the general health was exceptionally good for one or two months previous to the appearance of the first cases. It was only later, when the cholera was well established, that cases of cholera and diarrhœa were observed.

*Third.*—Cholera remained almost circumscribed in the towns and villages upon the border of the sea. This is explained by the habit of these people of not going into the interior of the country. Some cases, however, appeared in places in the neighborhood following the arrival of emigrants. Quimper, head of the department, which has more frequent communication with all of the smaller towns, is the sole town in the interior which was the seat of an epidemic,



*Fourth.*—In each of the places attacked—at Quimper, as in the various ports—cholera remained localized, especially in certain quarters, and the epidemic presented the character of an epidemic only in the houses.

*Sixth.*—It is important in every place to expedite the drainage. At Poulgoazec, more especially, is it urgent to facilitate the removal of water and putrid matter which encumber the principal street, inasmuch as at the foot of this street is found the well which supplies the place with water.

*Seventh.*—Water has evidently played a rôle in the propagation of the disease at Guilvinec. This agency, although not so well proven, appears probable at Quimper and for a quarter of Douarnenez. It was absolutely nil at Audièrne, and especially at Concarneau.

*Eighth.*—Audièrne presented numerous conditions of insalubrity with respect to the soil, the rooms, the absence of pure air, crowding, form of beds, etc.

*Ninth.*—There were hardly ever water-closets in the houses. In some was found a sort of cask. These casks are not ordinarily covered, and when there is a cover the closure is not perfect. Usually excrement is thrown upon the ground before the houses and serves to infect the subterranean water.

*Tenth.*—The towns and villages which presented the most deplorable hygienic conditions were those most severely attacked by the epidemic. At Guilvinec, where these conditions are especially deplorable, the cholera ravaged the place with great intensity and spared Lechiagat, a village situated opposite, of which the conditions were very superior. Moreover, typhoid fever appears epidemic at Guilvinec, and spares ordinarily Lechiagat. Also at Audièrne as well as at Poulgoazec, where there is a population of 2,000 inhabitants, 200 cases of typhoid fever occur annually.

*Eleventh.*—A certain number of measures have been taken to combat the epidemic. An endeavor has been made everywhere to disinfect, but isolation has been practiced nowhere save at Douarnenez and at Quimper, the attempts at disinfection of rooms being very imperfect. Nevertheless, in all the towns that we have visited, we were able to see the diffusion of ideas concerning disinfection, and of numerous attempts, often very rational, in the application of these notions.

*Twelfth.*—The hygienic measures to be immediately enforced relate to isolation and disinfection of the localities. It will be necessary to exercise a rigorous watchfulness at the time of the overcrowding which will take place at Audièrne and Guilvinec when the fishing season begins. The ulterior measures look more especially to the supplying of pure water, the suppression of wells, the cleaning of streets, and the creation of water-closets.

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#### CHOLERA EPIDEMIC IN GUILVINEC IN 1885.

A report of the prefect of Finistère, M. Monod, concerning the epidemic of cholera at Guilvinec, in 1885, presented before the Society of Public Medicine, in Paris, 24th of February, 1886, covers much the same ground as that already quoted of Dr. Proust, inspector-general sanitary service, and confirms Dr. Proust in the points touched upon by him, as well as advances some additional points of importance, some of which are presented below.

The epidemic of Guilvinec extended from the 30th of September to the 13th of December. For the preparation of his report the prefect had exceptional facilities. The mayor of the commune is a fisherman, who at the commencement of the epidemic laid up his boat and devoted his time exclusively to lessening the suffering, encouraging, caring for, and assisting his citizens. He had been mayor of Guilvinec twelve years ago. There is not an inhabitant that he does not know, and he is therefore able to furnish abundant and exact information concerning the epidemic. M. Monod adds that the mayor has exercised great circumspection and taken extreme care not to exaggerate, and that all he has told is worthy of entire confidence. This is the principal reason why the study of the epidemic of Guilvinec was undertaken. A second reason, moreover, is the relative importance of this epidemic and the small

number of cases to examine. Guilvinec has about 2,000 inhabitants. But at the beginning 1,200 to 1,300 fled, and only 700 to 800 remained. Of these there were 125 cases and 71 deaths, thus giving a mortality of 10 per cent. of the population; yet this number of 125 cases is sufficiently small to render possible a most thorough investigation. This is why the epidemic at Guilvinec appears to afford a good field for study.

Guilvinec is a large fishing town of recent date and of a rapidly increasing population. During the month of last September it was in constant communication with Concarneau, which was suffering with cholera at that time. The first victim was attacked the 30th of September, and died the next day; it was a woman, sixty-seven years old, whose son-in-law, with whom she dwelt, had been a few days previous at Concarneau, and had just met some soldiers from Concarneau, at Penmarch, where the first case of cholera occurred on the 25th of September.

The information received concerning the epidemic is collected by the prefect in six tables appended to his report. Included in these tables, among other data, is information concerning the mode of attack of patients who had been attending upon individuals. Transmission has been indicated only when it has been absolutely proven.

In the last table, No. 6, is graphically indicated the transmission from patient to patient, when it has been absolutely proven. Among the 125 cases, transmission from individual to individual seems proven in 92, which number may be divided into twenty groups of cholera families. These families are composed of 112 persons. The two most numerous groups contained 23 and 26 respectively. In the first, the common ancestor (or originator) is a child of three years, which died. In the second, it is a woman, who was cured, but who caused 25 cases of cholera, 18 of which terminated in death.

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*TEACHINGS CONCERNING THE ETIOLOGY AND PROPHYLAXIS OF CHOLERA EPIDEMICS OF THE LAST THREE OR FOUR YEARS.*

Dr. Proust,\* discussing the experience concerning the etiology and prophylaxis of the cholera epidemics of the last three or four years, has thus described the epidemic in France of 1884-'85: The development of the epidemic presented three stages. In 1884 cholera was imported into Toulon, from there it spread to Marseilles and vicinity, thence it traveled to Paris and extended to the neighboring towns, and finally disappeared towards the end of the year. In the spring of 1885 it appeared again in Marseilles and Toulon, probably in consequence of a recrudescence of the seeds of the epidemic only temporarily extinguished. Finally, in the latter part of 1885 it was again imported, probably from Spain. Comparing the last epidemic in France with former visitations, one finds many similarities in their course. The epidemics always begin in a frontier department, and indeed in one bordering upon the sea. Furthermore, it is demonstrable that the epidemic spreads to the adjacent surrounding towns with greater or lesser promptness according to the more or less favorable conditions for development which they afford. The mortality in this epidemic was much less than in the former; thus in the epidemic of 1884-'85, in France, the mortality was 12,000, whilst in that of 1832 there were 120,000 deaths, in that of 1848-'49 110,000, and in that of 1853-'54 140,000.

The epidemic of 1884-'85 has furnished strong proofs of the contagiousness of cholera. The conveyance of the contagium is effected, as may be definitely established, through personal effects and their washing, through the water, and through certain kinds of food. On the other hand, this epidemic furnished no example of a transmissibility of cholera through the air, at least to any great distance. Nevertheless, the air may serve as a vehicle for the cholera contagium in the confined space of the sick-room.

The benign character of the last cholera epidemic in France is to be attributed in most part to the stringent prophylactic measures enforced.

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\*Of Paris, at the Sixth International Congress for Hygiene and Demography, in Vienna, 1887. *Deutsche Med. Wochenschr.*, 24 November, 1887.



Unquestionably it is very difficult to prevent the introduction of cholera into Europe when it has already passed the Red Sea, do what we may. Preventive measures must differ according as they are of maritime or terrestrial application. With respect to the maritime stations, the regulations of 1876 were enforced in France. On account of the contradictory state of our knowledge and the decided interference with international commerce, their number and duration were lessened as much as possible.

Land quarantines in France were abandoned in 1885, whilst cholera raged in Spain. Posts of observation were established upon the various land routes between France and Spain. Since this measure had proved useful in 1885, it was repeated in 1886 during the epidemic in Italy. At the same time the importation from Spain and Italy of soiled clothes, bedding, covering, etc., was interdicted.

Posts of observation were also established in the stations of the direct railroad lines connecting with the railways of Southern France, in order to restrain the spread of cholera through the country. Meantime, all the measures relating to public and private hygiene were enforced in the principal cities of France. It is certain that the mildness of the last cholera epidemic in France is attributable in the greatest part to those measures.

*ABSTRACT OF THOINOT'S ACCOUNT OF THE CHOLERA EPIDEMIC OF 1884 IN FRANCE.\**

*CHOLERA FOLLOWS WATER-COURSES, AND ESPECIALLY THOSE OF LITTLE IMPORTANCE, SUCH AS TORRENTS AND SMALL STREAMS.*

It has for a long time been remarked that cholera follows the course of water, as it does highways and railways, and the epidemic of 1884 furnishes numerous examples of this mode of propagation.

The Basses-Alpes were slightly affected by the epidemic, which attacked only eighteen communes—the majority of these being located upon three different water-courses, the Asse, the Ubaye, and the Jabron. Upon the Ubaye, an affluent of the Durance, we find from above, downward—Jausiers, Barcelonnette, Thuiles. Upon the Asse, affluent of the Durance, to the south of the Ubaye, are situated from above, downward—Barrême, the hamlet of Chabrières, and Mezel; upon the Jabron are Omergues, Montfroc, Saint-Vincent, and Noyers-sur-Jabron.

In the Hautes-Alpes we will mention the epidemic of the valley of the Oule: from above, downward, we find upon the border of this small stream, an affluent of the Eygues, the hamlet of Peyguière (a dependence of Epine), Montmorin, Bruis, and finally Charcé. Upon the banks of the Méouze are located Lachau, Salérans, and Barret-le-Bas. Upon the banks of the Ardèche are found from above, downward, Bégude, Pont-d'Ucel, Pont-d'Aubenas, Vougué, Pradon, and Ruoms.

In the Ariège, five communes only were attacked; three of these are upon the banks of the same water-course, the Salat, viz, Eychiel, Saint-Lizier, and Saint-Girons.

In the department of Aude, upon the banks of the Aude, cholera attacked Couiza, Limoux, Carcassonne, and Coursan. One of its affluents, the Orbiel, has upon its banks Conques, Villalier, and Bouillonac. In the same department, upon the banks of the canal du Midi, the cholera attacked Castelnaudary, Carcassonne, Ventenac-d'Aude; and finally, further down, Capestang and Agde in Hérault.

In the Bouches-du-Rhône all of the communes bordering the Huveaune were reached by the epidemic—Auriol, Roquevaire, Aubagne, and Penne.

In the Gard, upon the banks of the Ceze, are located Bessèges, Robiac, and Saint-Ambrois.

Upon the Vidourle we find Vigan, Sauve, and Quissac.

In the Haute-Garonne, of twelve communes attacked, four formed part of the same valley: these are Sengouagnet, Aspet—or rather its two hamlets, Sarradère, Fontagnères—and Soueich, upon the Ger, a small affluent of the Garonne; and upon the brook Rossignol, an affluent of the Ger above Aspet, the commune of Milhas.

\* By Dr. L. H. Thoinot, Paris, 1886.

In the Hérault cholera attacked, upon the banks of the Orb, Bédarieux, Béziers, and Serignan; and upon the banks of the Hérault, Belarga, Bessan, and Agde.

The Pyrénées-Orientales offer two most complete examples of the grouping of the affected communes upon natural water-courses (brooks and rivers), or artificial ones (irrigation canals). If after having dotted upon a map the communes attacked one looks at the grouping, one sees that the communes to the north and the south are grouped en mass along the Têt and the numerous irrigation canals which are derived from it, while in the rest of the department it is also along the borders of the rivers Agly, Tech, or the canals, that one must seek for the attacked communes.

Upon the Agly are found Estagel and Rivesaltes. Upon the Tech, Arles-sur-Tech, Boulou, and Brouilla. Upon the Têt, Rodès, Ille-sur-Têt, Millas, Saint-Félicien-d'Amont, Saint-Félicien-d'Aval, and Perpignan. Upon the canal Vernet and Pia, derived from the Têt, Saint-Estève, Pia, and Torreilles. Upon the canal Moulin de Villelongue, derived from the Têt, Villelongue-de-la-Salanque and Sainte-Marie. Upon the canal Thuir, derivative of the Têt, Ille, Thuir, and Toulouges. Upon the canal Corbère, derivative of the Têt, Boule-Ternère, Saint-Michel-de-Llottes, Corbère, Corbère-les-Cabanes, Canohes, and the quarters Saint-Jacques and Réal de Perpignan.

In the Var, upon the Argens, are located Correns, Montfort, Carcès, and Vidauban; and upon the Caramy, affluent of the Argens, Brignole, Vins, and Carcès.

In the department of Vaucluse, upon the Sorgue, cholera invaded Isle, Thor, Saint-Saturnin, and Sorgues.

Finally, among large water-courses common to several invaded departments, we find the Durance and the Rhône. Upon the banks of the Durance cholera attacked Savines (Hautes-Alpes), Sisteron (Basses-Alpes), Puget and Cavaillon (Vaucluse), Mallemort, and Orgon (Bouches-du-Rhône). Upon the banks of the Rhône we see Tournon (Ardèche), Aramon, Valabrègue, Beaucaire, Fourques, Tarascon, and Arles in Bouches-du-Rhône.

This rapid review makes clear the two points to which we wish to call attention. Cholera follows the water-courses in its march, but it is especially along the small streams that this propagation is most frequent and remarkable.

In order to explain this march of cholera, only three hypotheses are possible:

(1) It is only a pure chance. But then one must confess at least that the fact is very frequent and often repeated to be the effect of mere chance.

(2) The streams, the torrents, the rivers are contained within a valley often narrow and inclosed, and the villages which are located therein often have intercourse only among themselves. When one is attacked it is very natural that the others should be in their turn. This explanation is very plausible for some cases, and we shall see that the cholera of the valley of the Méouze can not be explained otherwise. It appears to us also that the large rivers, the large water-courses along which are located places attacked by cholera, act in the propagation of cholera like grand routes and railways, solely because they are the means of frequent travel by emigrants.

(3) Water is a propagator of cholera. It is the water of a torrent, of a brook, of a river which, contaminated at a point in its course, transmits the cholera to the inhabitants along the banks who use it below that point. We shall now attempt to establish this proposition by citing the history of cholera in some districts of France.

*WATER IS A MEANS OF PROPAGATING CHOLERA FOR BOTH SHORT AND LONG DISTANCES.*

THE EPIDEMIC OF ARPAVON (DRÔME).

Monday, the 11th of August, the family A, from Omergues, fleeing from the cholera, arrived at Arpavon (Drôme, arrondissement of Nyons). The Auberts received them, but the day after, yielding to the pressure of the frightened populace, the mayor, by order, sent the family A to the Arnaud farm, 1 kilometer distant from the village. The family A was composed of two brothers, one of whom was married, and of two children. The youngest of the two brothers had diarrhœa for some time. He left the village of Arpavon on the 12th,



and reached the Arnaud farm, where the other members of the family rejoined him, on the 13th. The altitude of Arpavon is 700 meters. Below it the route from Sidéron passes and the river Ennuie flows.

The Arnaud farm is situated in a locality traversed by numerous ravine springs, which flow into the Ennuie. The Arnaud farm is watered from the spring Charaye, of remarkable purity and limpidity, which flows down the ravine of Combes. The waters of this stream serve for the use of all of the farms along its banks, which we shall enumerate. At 300 meters below the Arnaud farm, and upon the same bank (the left) is found the Clary farm, and immediately below the latter, the Buisson. Upon the other side of the stream, opposite the Buisson farm, is the des Bœufs farm; but the latter is distant from the banks of the Charaye, and does not make use of this water. It is supplied from a special spring which has no communication with the Charaye.

When the family A, from Omergues, was installed at the Arnaud farm, the wife, not understanding the danger she was to causing, committed the imprudence of contaminating the water of the Charaye by washing in it the soiled linen of the younger brother attacked with diarrhœa. Besides, this young man often arose during the night to defecate upon the borders of the stream.

It was, evidently, not a simple and benign diarrhœa with which young A suffered. Its choleraic nature could be proven, for on the 19th of August the son Arnaud, of the family of the hostess of the A's, was suddenly seized with an attack of cholera, and died in a few hours. The family A left the Arnaud farm at once upon the evening of the 19th, when the Arnaud son died.

During the death agony of the son Arnaud, Alexis Clary, the proprietor of one of the farms situated below that of the Arnauuds, the situation of which we have above indicated, was seized in his turn with vomiting and diarrhœa. Alexis Clary had had no communication with the Arnauuds since the arrival of the family A. "Having a terror of cholera, he had taken care not to enter the farm of Arnaud while the emigrants from Omergues sojourned there. Obligated to pass before this farm the evening before his death, he spoke to Mr. Arnaud, but from a distance. He did not touch him in any manner, nor anything which belonged to him." But Alexis Clary had passed the day in the field, and had carelessly quenched his thirst with the contaminated water. This unfortunate young man, upon returning in the evening, suddenly fell sick, and died the day after.

The same day, the 19th, Buisson, whose farm joined that of the Clarys below, had passed the day with his family in watering his garden, and he also had carelessly drank of the water of the Charaye. Buisson, as well as Clary, had avoided all communication with the Arnauuds and the emigrants. The evening of the 19th, at the request of the curé of Arpavon, he went to Nyons to seek aid for young Arnaud, but had scarcely started when he was seized with the first symptoms of cholera, and returned and went to bed with the characteristic signs. His daughter was attacked on the 21st, that is to say, twenty-four hours after; then his wife.

The inhabitants of des Bœufs farm are opposite the farms of Clary and Buisson, upon the other bank of the Charaye, but the water which they use, as we have above stated, is not the water of the Charaye. They were entirely free from attack, while the two farms, Clary and Buisson, paid a heavy tribute to the epidemic.

To resume: A person suffering from cholera presenting only one symptom, a slight diarrhœa, arrived from Omergues in the suburbs of Arpavon. He contaminated with his dejections the stream which flows past the farm where he dwelt; his mother washed his contaminated linen in the same stream. Below are situated three farms the inhabitants of which, fearing the cholera, avoided the refugees as bearers of the pest. The inhabitants of two of these farms used the contaminated water; they paid a heavy tribute to cholera. The inhabitants of the third went free; they did not touch in any manner the water of the contaminated stream.

#### THE EPIDEMIC OF LA BÉGUDE.

Cholera had attacked, at La Béguide (Ardèche, arrondissement of Privas), two houses in the vicinity of the Station, when a distant house was invaded, situated in the quarter of the Usines, and without any communication with the former. Besides, this house was the only

one attacked in the quarter of the Usines, and the epidemic was most violent—four attacks, of which two were fatal, in a family of five persons. There was only an infant at the breast spared. The water serving for the use of this house was drawn from the small canal called the Beaulière, a derivative of the Ardèche, which flowed not far from the habitation. This was the only house in the quarter which used that water. All the other houses used water from a spring which emerged from the alluvial sand, and was supplied by filtration from the Ardèche.

Now, a single woman of La Bégude consented to wash the cholera linen of the first two families attacked in the quarter of the Station: it was in the Beaulière, at a few meters above the point where the family in the quarter of the Usines were wont to draw the water, that she washed more than one hundred and fifty pieces of soiled linen.

#### THE EPIDEMIC OF TULETTE.

Tulette is a commune of Drôme (arrondissement of Montelimar, canton de Saint-Paul-les-Trois-Châteaux).

The canal from Saint-Maurice passes by Tulette; it is called Moulin. Toulette is 4 kilometers from Saint-Maurice. Saint-Maurice was invaded by cholera, and just two houses which bordered upon the Moulin Canal furnished the cases. It is proven that the dejections of these patients, as of all those of Saint-Maurice in general, were thrown without disinfection into the Moulin Canal. Now at Tulette, in the second fortnight of August, 7 cases of cholera appeared, all, without exception, among washerwomen who had been in the habit of washing in this canal.

#### THE EPIDEMIC IN THE VALLEY OF THE JABRON.

The Jabron is a torrent tributary of the Durance, and rises in the Basses-Alpes, in the middle of the commune of Omergues, all of the hamlets of which surround its source. Then it traverses the commune of Montfroc, in the department of the Basses-Alpes. A hamlet of this commune, La Bégude, is upon the right bank of the Jabron, and two others, Asnières and Chamor, are upon the left bank. At La Bégude the water of the Jabron is used. At the two other hamlets water from a stream which descends from the Lure is used. Next upon the banks of the Jabron (left) are situated Saint-Vincent and Noyers-sur-Jabron. More distant and to the right are located Chateauneuf-Miravail and Valbelle, both upon small affluents of the Jabron; to the left, Cures and Bévons in the mountain. Finally the Jabron empties into the Durance below Sisteron.

Upon the 15th of July, at Omergues, in the hamlet of Michelet, cholera appeared in a house which had given hospitality to some Marseilles people, husband and wife, the latter convalescing from cholera. After that cholera prevailed at Omergues from the 15th of July to the 12th of August, occasioning great alarm and carrying off 32 persons in a population of 300 souls.

The inhabitants of Omergues used the water of the Jabron for all purposes, and did not for a single instant, during the epidemic, cease to contaminate it by the washing of linen of cholera patients, and by emptying into it excrementitious matter. The 6th of August cholera appeared at Montfroc, in the hamlet of La Bégude, which used the water of the Jabron, sparing the hamlets upon the opposite bank which drew their water from the stream descending from the Lure.

The 4th of August cholera made its appearance at Saint-Vincent, and at length at Noyers—the inn-keeper being taken off by cholera—but Chateauneuf-Miravail, Valbelle, and Bévons escaped. Cures had the cholera; but in this case there was no doubt of direct importation from Toulon.

The dissemination of the cholera along the Jabron below Omergues, sparing the places which made use of other water, attacking those which used the water of the Jabron, is certainly a curious fact. Undoubtedly, intercommunication between the uninfected communes and the contaminated communes played a certain rôle, since in that way it probably came to



La Bégude from Omergues, and also to Saint-Vincent; but it is none the less true that the study of the narrowly limited spread of the disease, as we have above described, leads to the idea that the contaminated water played a more than secondary rôle.

THE EPIDEMIC IN THE VALLEY OF THE GER (HAUTE-GARONNE).

Professor Laboulbène presented the following account of this epidemic to the Academy of Medicine:

I have just submitted to the Academy an account of a small epidemic of cholera observed in a canton on the Pyrenees. The part which contaminated water plays is there very decided. It concerns the canton of Aspet (Haute-Garonne), where cholera suddenly made its invasion in the month of July, 1884. Struck by the influence attributed to water in this epidemic by my friend Louis Ruau, director-general of the mint, whose family was located at Aspet, I obtained exact information, through the kindness of two physicians of the locality—Drs. Sauné and Cazes. Moreover, Mr. Joseph Ruau has drawn a map of the places attacked, and I lay it before the Academy.

The two reports of the epidemic at Aspet correspond. Here are the facts collected by Dr. Sauné:

The cholera epidemic began suddenly at Milhas, in the canton of Aspet, the 20th of July, 1884. There was a case of Asiatic cholera in a woman. Dr. Sauné saw the patient at 2 o'clock in the afternoon; she died at 7 o'clock in the evening.

This patient had not left Milhas. She belonged to a family of peddlers who ordinarily lived at Marseilles, and who, fleeing from the cholera epidemic in that town, returned to their country. One of the girls had attended two ladies who died of cholera in the same street where she dwelt. Some of the clothing which belonged to them was given to her. Moreover, the trunk brought from Marseilles to Milhas contained unwashed clothing of her father, and her father had suffered choleraic diarrhoea for some time. The clothing was the agent of transmission; it was handled and washed by her mother and one of her daughters. Both were attacked, and died the same day, almost at the same hour, one at Milhas, the other at Montsaunés, where she went to visit one of her relations.

Why did the case of Montsaunés remain isolated? Why did the cholera develop slowly at Milhas? Here is the explanation of Dr. Sauné. The two villages are distant 21 kilometers. The first has no water-course; the second, on the contrary, is traversed by a slow brook which empties into the Ger, which is called Rossignol, or Milhas Brook.

The first house attacked at Milhas is situated exactly on the bank of the stream, in the quarter Mourere-Rouge, by the side of a plaster mill. All the night-soil, washing suds, etc., were thrown from the window into the water. The linen was washed in the water, and the dejections of the first cholera patient were thrown into it, no prophylactic measures having been taken before the arrival of Dr. Sauné.

This is the most important point of the observations made. After the first case, all the houses attacked were located near the brook, and down stream. No case appeared above the location of the first house attacked. There were, however, three other hamlets in this long and very narrow valley.

The 21st of July the second case appeared in the village, and up to the 31st of August there were 22 attacks, 16 deaths, and 6 recoveries.

The small brook of Milhas empties into the Ger, a river which flows past the capital of the canton Aspet. Here also cholera appeared, following the course of the water. The first case attended by Dr. Sauné appeared at Sarradère, between Milhas and Aspet. The road is between the river and the house attacked. Three deaths took place in this little hamlet.

From Sarradère the cholera still followed the water. It had no victim in that part of Aspet located upon a hill quite distant from the Ger. It severely affected, on the contrary, the inhabitants of the hamlet of Fontagnère, the houses of which are located upon the bank of the river. Dr. Sauné estimates in this village 300 inhabitants; 19 deaths occurred in twenty-three days. During a Sunday 5 deaths occurred, 3 in the same house.

Beyond Aspet the Ger passes by Soueich. There were 12 deaths in this commune. The epidemic stopped at this point.

Dr. Sauné made this general remark: The epidemic attacked especially the feeble. In this last epidemic the patients died more quickly than in preceding ones, the mean not extending over twenty-four hours of illness.

The account of Dr. Cazes confirms the preceding observations. It contains, in addition, curious information concerning all the localities and the propagation of the disease.

Dr. Cazes declares that he is absolutely sure that before the middle of the month of July there was no case of cholera in the communes of Milhas, Aspet, and Soueich, or in any other commune of the canton of Aspet, or in any adjoining canton.

The 16th of July, 1884, a family of emigrants from Marseilles, consisting of the father, still convalescing from an attack of cholera, and four children, spared by the disease, arrived in the commune of Milhas. All went to stay in a small, dirty, low, moist, damp house, adjoining the stream, which was occupied by a woman who had never left the commune, but soon thereafter was attacked with cholera. The emigrants placed in this unhealthy dwelling baggage, linen, and clothes which had been used by cholera patients in Marseilles. They soaked a part of these in the running stream.

After living together four days, the occupant of this house, wife of a patient attacked with cholera at Marseilles, was carried off by *foudroyant* algid cholera in six hours. Almost at the same hour, her daughter, going to visit in the same commune, was upon her arrival attacked with *foudroyant* cholera, which terminated also in the algid stage.

After these 2 deaths, the family of emigrants left the house and as a precaution went to remain in another and more healthy place near a wooded spot far from the stream. No other accident happened to them.

Dr. Cazes expressly remarks that at a kilometer up stream from the first stopping place of the emigrants, and upon the bank of the Milhas brook, are located 100 inhabitants. Notwithstanding the bad hygienic conditions, and privations of every sort, these inhabitants remained free of cholera. The same was not the case with the people in better circumstances dwelling about a kilometer below this first house. The brook as it traverses this part of the town spreads out in several places. Here the course of the water is very slow, and the accumulation of filth, excrement and sediment is thereby favored. It is in the neighborhood of these pools of impure water that the inhabitants, in the absence of fountains, go to draw water which they daily need for household use, and it is in this locality that, eight days after the first 2 deaths, 2 other rapid deaths occurred, the latter also not having passed the algid period.

To these cases were added 20 others during the month of August, and the attacks followed step by step the course of the stream.

The distance between the commune of Milhas and that of Aspet is 4 kilometers. The brook of Milhas empties into the Ger, a small river of Aspet, at a distance of 3 kilometers from this last commune. The united streams pass below Aspet through two hamlets of the suburbs of Aspet, viz, Sarradère, and the lower parts of Fontagnère, as also of Baleijon. All the other places around Aspet, distant from the river, are situated upon the side of wooded hills and experienced no cholera.

Sarradère and Pontanières suffered greatly from the epidemic. In Sarradère the first *foudroyant* case occurred on the 6th of August, and on the 7th a second fatal case. After an interval of four days, 3 severe cases occurred on the 8th, 10th, 11th of August, terminated by a cure after a long and troublesome convalescence.

Dr. Cazes observes that the inhabitants of the lower part of Sarradère used exclusively the river water and were attacked. In the higher part which remained free from the disease the inhabitants drank the water of the Souvier.

Fontagnère, below Sarradère, as well as the houses of Baleijon along the banks of the stream, received the combined waters of the Milhas and Aspet. The epidemic showed itself at first in 3 slight cases, followed by recovery. After a period of calm, it spread without interruption until the 1st of September. There were 35 cases in a population of 300. The num-



ber of deaths reached 19, of which 11 were *foudroyant*; the 16 cures had a long and painful convalescence. In the absence of fountains, the inhabitants made use of the water of the river. They were commonly badly lodged and poorly fed.

The commune of Soueich, which is 4 kilometers from the Aspet, is traversed by the Ger. The ground is flat, damp, and there are frequent fogs; no distant springs, well-water or river-water serving for domestic use. The streets are very dirty, and the courts of the houses are encumbered with dung. The sewerage and fecal matter empty into the river. Counterbalancing this, the easy circumstances of the families correct to some extent this bad hygiene and the bad condition of the soil.

The epidemic began in this commune ten days later than in the suburbs of Aspet. It bore especially upon the needy class. There were 22 cases, 11 deaths (4 *foudroyant*), and 11 cures.

#### THE EPIDEMIC OF THE PYRENEES-ORIENTALES.

The 17th of July, 1884, the first case of cholera appeared in the Pyrénées-Orientales, at Boule-Ternère (arrondissement of Prades).

"The 15th of July, 1884, the family Oliva, composed of three children, father and mother, coming from Toulon, arrived at Perpignan, and went to Boule-Ternère. Mr. Louis Trie, suffering some days with diarrhœa, went to visit his relatives, the Olivas, and was attacked the day of his arrival by a slight disturbance of digestion, attributed to the fatigue of the journey, or to another cause, that he came from an infected town. Mr. Trie, sixty-two years old, showed choleraic symptoms the 17th of July. His malady rapidly became grave on the 18th, and he died on the 19th. His wife was attacked in her turn, and died on the 22d of July. Finally the son-in-law of Trie, and his two daughters, suffered attacks, which terminated fortunately. Then 4 deaths took place in the neighborhood at intervals of a few days.

Boule-Ternère, situated 6 kilometers to the east of Vinça, and 31 to the west of Perpignan, is watered by the river Boules and the irrigation canal called the Corbère.

The Corbère Canal serves for irrigation and water supply for domestic purposes at the same time. It leads from the Têt, in the neighborhood of Vinça, runs near Rodès, and Boule-Ternère also, from which point it passes by Saint-Michel-de-Llottes and Corbère, as far as Corbère-lès-Cabanes. Then it communicates with the canal Thuir, which it crosses perpendicularly, and goes to terminate in the brook of Perpignan or canal Las-Canals, which is derived from the Têt at the upper part of Ille, and ends at Perpignan. We will now point out the great agency of the water of this canal on the propagation of cholera.

It is proven undoubtedly that at Boule-Ternère the inhabitants threw into the Corbère Canal choleraic dejecta, and washed in it cholera linen. From the time when Boule-Ternère was infected with cholera, the march of the epidemic in the department was as follows: Corbère is attacked the 24th of July (2d); Saint-Michel-de-Llottes, 30th of July (3d); Thuir, 1st of August (4th); Corbère-lès-Cabanes, 3d of August (5th); Saint-Félic-d'Aval, 5th of August (6th); Rivesaltes, 7th of August (7th); Toulouges, 9th of August (8th); Perpignan, 10th of August (9th). Of these eight places, two only, Saint-Félic-d'Aval, and Rivesaltes, are out of the neighborhood of the canal Corbère, as also of the Thuir, Las-Canals, or of Perpignan.

Saint-Félic-d'Aval owes its cholera to a direct importation from Corbère. Rivesaltes was infected in a special manner by its relation with Marseilles and the ports of the Mediterranean.

With these exceptions the cholera followed, without leaving them, the lines of the canals above stated. It is at first Corbère which is attacked; then Saint-Michel-de-Llottes, both upon the Corbère Canal; Thuir, upon the Thuir Canal, which communicates with the Corbère Canal; Corbère-lès-Cabanes, upon the Corbère Canal; Toulouges, upon the Thuir Canal, below Thuir. Finally, Perpignan, end of the canal of Las-Canals, where the canal Corbère terminates. It should be added that as the cholera advanced from point to point each locality newly attacked down stream repeated the detestable practices followed above; thus at Corbère and Saint-Michel-de-Llottes the dejections of cholera patients were thrown into the stream, and the soiled linen was washed in it. It is easily comprehended how this practice increased the probability of infection of the places below.

From these facts, presented thus without comment, it is quite natural to conclude that the canal of Cobère, and those which prolong or are tributary to that canal, have played a prominent rôle in the progress of the cholera. But let us enter into details; the demonstration will become more striking.

Boule-Ternère, as we have said, is in the canton of Vinça. This commune is surrounded in the canton by other small populations with which it has daily and certainly more frequent communication than with the communes scattered along the canals of Corbère, Thuir, and Las-Canals, of which communes Perpignan, the last, is 31 kilometers from Boule-Ternère.

The communes of the canton of Vinça are: Vinça, *Ballestany*, Boule-d'Amont, *Confabre*, Espira, Estoher, Finestret, *Glorianes*, Ille, *Jock*, Marquixanes, Rigarda, Prunet, Rodès, Saint-Michel-de-Llottes, *Vulmanta*. With the exception of five (those designated by italics) all these communes have been attacked; but, save Saint-Michel-de-Llottes, the situation of which is well known, not a single one was reached by the plague until it had spread the entire course of these canals and finally attained their extremity, that is to say, Perpignan.

Perpignan, as we have said, was the ninth commune attacked in the Eastern Pyrenees. In the group of communes of the canton of Vinça, the first attacked was Boule-d'Amont, which in the order was only the eleventh invaded in the department; then came Prunet and Rodès, as No. 16; Ille, 18; Vinça, 19; Marquixanes, 24; Rigarda, 29; Estoher, 30; Espira-de-Confient, 32; and Finestret, 34. And, moreover, as might be expected, it is in consequence of their connection with Boule-Ternère that most of these communes have been attacked, such as Vinça, Rodès, Ille, Boule-d'Amont, Prunet. If the manner of choleraic contagion had been the same for the communes scattered along the canals from Boule-Ternère to Perpignan as for the communes of the canton of Vinça, that is to say by human importation, it would be difficult to say why it was that without exception the communes the nearest related, the most directly in contact with the first focus, should have been attacked last. But the fact of contagion by water for some (the communes scattered along the canals from Boule-Ternère to Perpignan) and of contagion by importation for others (the communes of the canton of Vinça) perfectly explains this difference.

We are now going to enter into details; we will encounter in so doing some arguments which we hope will plead in favor of our interpretation.

Grando, an agriculturist, who was the first attacked at Corbère (the evening of July 24), had had no suspected communication, according to the information furnished to Dr. Bocamy. At Saint-Michel-de-Llottes is encountered the same negative result. At Thuir the first case observed (August 1, 1884) made its appearance in a house situated on the square adjoining the church. The individual attacked had the evening before had communication with persons coming from Corbère, but Dr. Massine, of Thuir, positively assured himself that these people of Corbère coming from Thuir had not then and have not since had a single suspected symptom. "They brought neither fruit nor vegetables from their village to the inhabitants of Thuir." As a matter of fact, this would not be a sufficient reason for rejecting the idea of human importation, for instances of an incontestable value have been cited (and we will give some of them ourselves in this work) of people, not sick themselves, but coming from an infected locality, importing the cholera to a locality up to that time perfectly healthy.

But here is something very significant. Thuir possesses two fountains, A and B. Now the greater part of the cases of cholera, about two-thirds, were quartered in the district supplied with water by fountain A, and it was in this district that P., the first patient, resided. The sources of water of fountains A and B are quite different. A is supplied directly, for the greater part, by infiltrations from the canal of Thuir, hardly 60 meters distant; B receives its water from a field situated about 1 kilometer from the town and 500 meters at least from the canal of Thuir. But this is not all. A farm-house 2 kilometers distant from Thuir (the Peille farm), constructed on the border of the canal and using water therefrom for all purposes, had 2 cases of cholera.

But here is a final argument which to us appears conclusive: It is the spread of cholera at Perpignan compared with the distribution of the water. In addition to some artesian wells (at place Saint-Dominique, place de la Loge, place du Marche-Neuf, rue Saint-Martin, and rue



du Marche-aux-Bestiaux) and some wells situated in the interior of the houses, Perpignan is supplied with water by three canals bringing potable water from three different districts:

(1) The Royal Canal (supplying rue Saint-Martin and the barracks of the same name and all establishments included between this street and the right bank of the Basse) leading from the Basse.

(2) The canal of the Four Cazals, leading from the Têt, below Sainte-Eugenie, which empties into the Basse.

(3) The most important of all, the canal of Las-Canals, which supplies three fountains, two of which (the fountain of the Carèms and that of rue de la Fontaine-Neuve) supply the quarter Saint-Jacques and part of the quarter Real. Fed by the Têt at Ille, the canal of Las-Canals, or Perpignan brook, has received the waters of the canal of Corbère below Boule-Ternère, Saint-Michel-de-Llottes, Corbère, and Corbère-les-Cabanes districts, which, with the exception of Boule-Ternère, have been rendered contagious by the waters of the canal, and which in turn have not ceased to render the canal of Las-Canals still more dangerous by emptying into it the choleraic dejections and washings of soiled linen.

Now, observe what has taken place at Perpignan. After several cases more or less doubtful, or at least without result (observed at the close of July), the cholera breaks out violently in the quarter Saint-Jacques. The woman, Sanchez, of rue Bailly, succumbed in twelve hours. The 11th of August a child, ten months old, in the rue de Tracy (in the same quarter of Saint-Jacques), succumbed from cholera in ten hours. The 12th of August the woman M. was attacked and died in twenty-four hours, in rue Duchalmeau (Real quarter), and on the 13th the woman P. succumbed quickly at rue Grand Saint-Jacques (Saint-Jacques quarter).

From this moment the cholera spread rapidly, but preserved an intensity and gravity particularly remarkable in the Saint-Jacques quarter, where in one house, for example (No. 35 rue Grand Saint-Jacques), among 22 occupants there were 7 deaths from cholera out of 10 cases. Out of the total of 187 cholera victims, as many in the city as in the suburbs, the Saint-Jacques quarter, having hardly a sixth or seventh of the population, furnished 70 deaths; that is, a little more than one-third. It is interesting, from the same point of view, to observe that the citadel and garrison of Saint-Jacques, which receive water from the canal of Las Canals, had, the one 14 and the other 5 cases. The garrison of Saint-Martin (Canal Royal water) had only 1 case, and that was a soldier who had just been on duty at Saint-Jacques.

Therefore, does not the direct course of the cholera from Boule-Ternère to Perpignan, following the contaminated waters of the canal of Corbère, the canal of Las Canals, touching Thuir and Toulouges, tributaries of the canal of Thuir contaminated by the canal of Corbère; its first location at Perpignan, in the quarter supplied with water from the canal of Las Canals; its greater intensity in this same quarter—does not all this prove evidently the rôle played in the propagation of the plague of water contaminated by choleraic agency?

#### THE EPEDEMIC IN THE VALLEY OF THE OULE.\*

The Oule is a little stream tributary to the Eygues; which rises in the Upper Alps, receiving water from several original tributaries. One of these tributaries flows from the little hamlet of La Perguière, a dependence of the commune of Epine, at an altitude of 800 meters. From there the Oule flows westward, traversing successively the communes of Montmorin, Bruis, Sainte-Marie (in the Upper Alps), La Charce, and La Motte Chalançon (Drôme). There it makes a bend, and flowing southward finally empties into the Eygues.

The commune of Montmorin (altitude 729 meters) comprises several settlements: the hamlet of Serre-Boyer and the village of Montmorin, on the borders of the Route and of the Oule; the hamlet of Satuce (or La Chatuce) and Marayesse, both somewhat distant from the Oule and to the south of that stream; the hamlet of Infernet, north of the Oule and equally distant from its banks.

\* We have consulted, in editing these few pages, the report of M. Queirel on cholera in the Upper Alps. Abbé Lesbros, curé of Bruis, has had the kindness to send us some notes on the epidemic at Bruis and a sketch of the valley of the Oule. He was an eye-witness of the epidemic, and during it exhibited unceasing devotion to the suffering sick. Highly appreciated by all no one was in a better position than he to observe the epidemic. Dr. Laurens, of Nyons, has sent us his notes on Charce and La Motte-Chalançon. (Note of Thoinot.)

The commune of Bruis (altitude 698 meters) comprises, on the right bank of the Oule, the settlements of Teron, Bruis village, where the Château Andreoly, to which we will frequently refer, and La Serre are located; and on the left bank, Malafoux. To the south of the Oule, and at a considerable distance, is La Caoud; to the north the hamlets of Fontettes, Mianes, and Rochas; all—the last named particularly—being considerably distant from the Oule.

The first case which made its appearance in this remote little valley, which, with the exception of Charce, had never before been invaded by cholera, developed at the home of the woman S. at the hamlet of La Perguière. A few days before her death this woman had received from Marseilles for a foster-child a bale of linen which she undid and washed in the Oule. She, as well as her servant, took the cholera and thereby exposed her foster-child and two neighboring women. Within one week from the 11th of August these four women died in this little hamlet of 12 inhabitants and at most eight houses.

The commune of Montmorin, below La Perguière, was next attacked. The woman Beaup had received at her house the foster-child of La Perguière. She took the cholera from this child, but got well, while the child died August 23. From the 22d to the 28th of August there were 8 deaths from cholera at Serre-Boyer. At Satuce there was 1 death, which makes a total for the commune of Montmorin (the village of Montmorin having no deaths) of 9 deaths among 17 patients. The hamlets of Mayraesse and Infernet were entirely exempted.

The cholera next reached Bruis in following the Oule; but we must add here that a package of linen and clothing, evidently infected, was brought from Marseilles to Bruis near the end of August by a young woman, the husband of whom had just died at Marseilles of cholera. The linen was washed in the Oule.

The village of Bruis was the first attacked. From the 20th to the 29th of August there were 10 deaths from cholera, not to speak of a large number of grave cases (23 for the commune). The first 2 took place at Bompert's house, outside the village and a little distance from the Oule, on the 20th and 21st. The château was a veritable focus; out of 5 persons there were 2 deaths the 26th and 28th, and 3 cases which did not result fatally.

About the same time, at Malafoux, on the left bank of the river, there was a death. The epidemic seemed to be coming to an end, terminating in cases of cholérine, when 2 fatal cases appeared at Teron the 15th of September, the victims being a resident and his wife. Finally the last death took place at the remote date of the 26th of October at Bruis.

Of the villages distant from the Oule, Fontettes alone produced a case, not an inhabitant of the neighborhood, but a woman who had left Bruis after the death of her husband.

The cholera next attacked Sainte-Marie, where from the 1st to the 15th of September there were two or three deaths from cholera.

On the 25th of September, at La Charce, a man who had just been engaged in cleaning an irrigating canal which received much of the water of the Oule, died from a frightful and sudden attack of cholera. Afterwards, from the 25th of September to the 7th of October, there were 2 other deaths, besides a large number of light cases and attacks of cholérine, in this commune of 181 inhabitants. The epidemic developed rapidly, without it being possible to discover and pursue the course of it.

Finally, at La Motte-Chalançon, 8 kilometers below La Charce, a case developed in a man who in his work had been in contact with the water of the Oule.

Let us resume hastily the history of this epidemic in the valley of the Oule, and add some necessary details to make it perfectly clear.

The Oule is a little stream with a sluggish current and not a great deal of water.

One of its principal tributaries receives at the hamlet of La Perguière first the choleraic germs contained in the effects coming from Marseilles and afterwards all the dejections of cholera patients of the hamlet and the filth of their linen. This is from the 8th to the 18th of August, about.

From the 22d to the 28th, in the commune of Montmorin, the hamlet of Serre-Boyer, bordering on the Oule, is attacked.

With the exception of Satuce, which, only had 1 death, the settlements of the communes at a distance from the Oule are exempt.



From the 20th to the 29th of August the commune of Bruis, immediately below that of Montmorin, is badly attacked by the epidemic; but the plague is confined to the borders of the Oule; the village of Bruis and its direct dependence, the château, on the right bank, and Malafoux, on the left bank, furnish the only cases and deaths. The settlements distant from the banks of the Oule, those to the north (Mianes, Rochas), as well as those to the south (La Caoud) are respected, with the exception of Fontettes, where a woman, who brings the germs of the disease from Bruis, is attacked.

At Montmorin, as at Bruis, the water of the Oule is only exceptionally used for drinking, but it is used for all other domestic purposes, and was even notoriously used for drinking at the houses of some of the victims.

Yet the Oule was newly contaminated at Montmorin and at Bruis by the bad habits of the inhabitants. It is proven that at Bruis a package of choleraic linen from Marseilles was washed in the stream.

From the 1st to the 15th of September Sainte-Marie, below Montmorin, is attacked.

Then, the 25th of November, La Charce, below Sainte-Marie, is invaded by a sudden attack of the plague. In a few days a large number of the inhabitants are more or less affected.

At La Charce they drank water from the Oule. "La Charce," Dr. P. Laurens writes me, "avoided carefully the choleraic villages up the stream. La Charce did not receive anything suspected; absolutely nothing, neither objects nor persons, I assure you."

We have, moreover, already seen where the first case was developed.

At La Motte-Chalançon appears finally a case, on the banks of the Oule.\*

Thus the cholera descends from Perguière, follows the banks of the Oule, attacking only the villages on the banks, and attacking them one by one from the source downward, at almost equal intervals. Is there another explanation possible than that of contagion by water?

#### CHOLERA ON THE BORDERS OF THE CARAMY AND THE ARGENS.

The Argens, which rises in the department of the Var, which it entirely traverses to empty into the Mediterranean, below Fréjus, receives, during the first third of its course, the river Caramy at Carcès. Along the borders of the Argens are situated the communes of Correns, Montfort, Carcès, and Vidauban; along the borders of the Caramy, the communes of Brignoles, Vins, Carcès, all stricken by the epidemic, and all, with the exception of Vidauban, forming part of the arrondissement of Brignoles.

Now, at Montfort-sur-Argens the little river Ribeirotte ends in the canal Saint-Jean, on which, further up, is the commune of Val.

The first case of cholera which appeared in the basin of the Argens showed itself the 6th of July at Brignoles, at the house of a man who had arrived the evening before from Toulon, where he was a disinfecter. Three days later, the 9th of July, a child two years old was attacked in its turn. The uncle of this child, a Toulonais, had been for a short time stopping at the house of the mother of the child, where several Toulonais had called. On the 10th and 11th of July, 2 new cases broke out in the same quarter. Now, this quarter is the nearest to the river Caramy, being only a few meters distant. During the warmest weather the water of the Caramy is not plentiful, particularly near the town, and the Caramy can be considered as the principal sewer of Brignoles. They do not drink the water of the Caramy, but they throw all sorts of filth into the stream; it is not necessary to add that the choleraic dejections were not an exception. From the time of the cases above cited the epidemic became fairly established at Brignoles.

Vins had had no case of cholera when on the 19th of July the woman G. Charlotte died in a few hours from a sudden and severe attack. This woman had not been out of the neighborhood for a long time and had had no suspected communications.

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\* The Oule empties into the Eygues, as does also the Ennuie, the river of Arpavon. Now, there were 2 cases only at Nyons, on the Eygues, below the junction of the Oule. "These 2 cases existed," Dr. Laurens writes me, "along the irrigating canal in houses which it supplied with drinking water." This canal is supplied with water from the Eygues, which receives the water of the Oule and also of the Ennuie, which flows by Arpavon.

Vins is ordinarily provided with abundant water of good quality, but in the year 1884, on account of the persistent drought the only fountain of the village was almost dry. So the greater part of the inhabitants brought their water from the river Caramy, infected up the stream at Brignoles. The woman G. had drank the evening before her death a large quantity of water taken from the Caramy.

The epidemic ceased for a month at Vins, and then suddenly spread from the 29th of August to the 6th of September, without any known cause, without importation from the exterior, among that population of 300 inhabitants, developing 7 cases, all fatal after a few hours, at the rate of a death a day.

Lower down, at Vidauban, on the Argens, several kilometers below the junction of the Caramy and the Argens, occurred an epidemic with sudden explosion, terrifying the population and resulting fatally in a few hours, and it was impossible to discover any other cause than the ordinary use of water infected above by choleraic germs.

Brignoles, further up on the Caramy, had been invaded for several days, and the waters of the Caramy and the Argens were thus already infected when the epidemic broke forth suddenly, carrying off in a few hours a man named G. Auguste, a harness-maker. G. had not been away from Vidauban and had had no suspected communications; besides, on the 16th of July, before his death, 2 new cases appeared in different parts of the village, both followed by death in a few hours. Thus, the simultaneousness of these 3 cases, without communication with each other, and without suspected exterior communication, is apparent. From the 16th to the 21st of July, 6 cases appeared, all resulting fatally.

Then the epidemic declined suddenly, there being but 3 more cases at a considerable distance from each other.

The first cholera patients certainly did not take the disease from each other; for only one case of transmission was observed, yet transmission is easily observable in a little settlement. The source was therefore a common one, and every argument points to the water being infected above Vidauban and serving to propagate the plague in that commune.

At Val, situated between the Caramy and the Argens, the epidemic made its appearance the 23d of July, imported from Marseilles or from Brignoles. Two ladies from Marseilles, mother and daughter, had come shortly previous to settle in Val, at a farm-house outside the village, and they made frequent visits to Brignoles, an infected locality. They were attacked with cholera, the mother the 23d, the daughter the 24th. Val is watered by a little river called the Ribeirotte, which flows towards Montfort, where it ends in the Saint-Jean Canal. Every day during the epidemic soiled linen was washed, and choleraic dejections thrown in the village gutters which emptied into this stream. Now, while there was not a single case above, further down several summer houses situated along this water-course were attacked after the epidemic had invaded Val.

But this fact is still more striking: Seven kilometers from Val, at Montfort-sur-Argens, two peasants were working in the fields situated along the Saint-Jean Canal, in which empties the little stream flowing from Val, the infection of which we have mentioned. These men, during the day, while at work, drank the water from this stream; they had had no suspected communication. Now, Val was invaded on the 23d of July, and on the 30th of July one of these men was attacked and on the 1st of August the other, both being carried off in less than twenty hours. Their attack was the prelude of the epidemic which invaded Montfort-sur-Argens, and which began in the same street where these men had died.

Thus we see in the arrondissement of Brignoles the cholera on the one hand was transported from Brignoles to Vins by the Caramy, and to Vidauban by the Argens; on the other hand, it was carried from Val to the houses situated below on the little stream Ribeirotte, and to Montfort-sur-Argens, where this little stream terminates.



*THE CHOLERA MANIFESTLY DEVELOPS AROUND WELLS OR FOUNTAINS, THE WATER OF WHICH HAS BEEN CONTAMINATED BY THE CHOLERAIC GERMS. IF THERE EXIST TWO KINDS OF DRINKING WATER IN A NEIGHBORHOOD, ONE INFECTED AND THE OTHER FREE OF ALL INFECTION, THE CHOLERA WILL ATTACK THE NEIGHBORHOOD OF THE FIRST BUT WILL SPARE ABSOLUTELY OR NOTABLY, AT LEAST, THE NEIGHBORHOOD OF THE SECOND.*

In discussing this subject, we will show : firstly, in the epidemics of Camps, Tourves, and Sènes, that the plague developed around wells or fountains containing infected water; secondly, that the epidemics of Prades and Vogue furnish examples of the cholera following the distribution of drinking water, attacking where infected water is used and exempting where the water is irreproachable.

#### EPIDEMIC OF CAMPS.\*

Camps is a commune of Var, arrondissement of Brignoles, the population of which amounts to 1,098.

The habits there are a little better and the comfort greater than in the major part of the surrounding communes ; but there is still much wanting in the hygiene of the town and the habitations.

There are hardly any privies ; the throwing of fecal matter in the street and gutter is continual. There is in the lower part of the village a kind of open canal which can be considered the principal sewer for all filth; the water of it is stagnant, and exhales, particularly during the warmer weather, a repulsive odor.

Camps is supplied with water by a spring furnishing excellent and abundant water. But this spring empties into a large reservoir, which constitutes an open fountain-reservoir. This fountain is partly strewn with débris of broken pottery and other débris. The beasts of burden go there to drink ; linen and vegetables are washed there; and the inhabitants are in the habit of dipping up the water while plunging jars and their arms, both more or less dirty, below the surface of the water. Added to this, the fountain-reservoir is separated from the running sewer by the thickness only of an ordinary wall.

The first case developed the 5th of September at the house of G. Albine, a woman of sixty-nine years, living at the entrance of the village, on the Brignoles side; she died the 7th.

The 12th there were 3 cases, 1 near the fountain. The 17th there were 2 frightful cases; the 18th another case, speedily fatal. The municipality then began to get excited. An investigation is made, and it is learned that the linen of cholera patients has been continually washed in the reservoir-fountain, and that the inhabitants of the invaded houses have continued to immerse their jars and arms in the fountain. The mayor then quarantines the fountain; his orders are scrupulously respected, and only 2 more cases are developed, on the 19th and the 21st. The epidemic suddenly ceased after the usage of this water ceased.

#### EPIDEMIC OF SENES.†

Sènes forms a little hamlet of 17 inhabitants, a dependence of the commune of Solliès-Pont (Var, arrondissement of Toulon). The habitations surround the only well. The first case of cholera appeared the 8th of July, in a young girl who had come from Toulon with infected linen and other objects. The next day, the 9th, a husbandman who had visited her was in turn attacked; then the greater part of the inhabitants were in a few hours attacked with choleraic diarrhea.

The 20th of July there died a woman who had washed the "suspected" linen of an inhabitant of Toulon. The sanitary condition of the people continued to be characterized by numerous diarrhoeas, when, suddenly, from the 15th to the 17th of August, in forty-eight hours, 8 inhabitants were carried off by frightful attacks.

Now, we have stated that there was only one well, in the center of the hamlet. It is absolutely certain that this well received the infiltrations of several neighboring irrigating canals where the inhabitants threw without any precaution the choleraic dejections, and where they washed soiled linen after the commencement of the epidemic ; and it was just after a violent

\*The Cholera at Brignoles (Dr. Patrìtti).

†Cholera at Solliès-Pont. Report of Drs. Gery and Bermondry.

thunder storm, that swept away all the filth and naturally mingled it with the water of the only well, that this sudden revival of the epidemic occurred, characterized up to that time by a few cases only, and at considerable intervals, besides many attacks of diarrhœa.

#### EPIDEMIC OF TOURVES.\*

Tourves (in the department of the Var and arrondissement of Brignoles), has 1,900 inhabitants, and is situated 11 kilometers from Brignoles.

At Tourves the greater part of the inhabitants pile dung in front of their houses and throw fecal matter in the street, a habit which continued during the epidemic in spite of the orders of the mayor. There are neither sewers nor sinks in the neighborhood, and the putrid matter descends in the gutters to the river Caramy, which flows a kilometer distant in the direction of Brignoles, which was infected before Tourves.

The water was good, but the springs were low for several months; the population drank from wells of a fair quality.

The first victim was Castellan F. (sixty-one years), who had recently been to Brignoles, where the cholera had broke out, and had sojourned in the house of a cholera patient. When seized, Castellan F. was working at a thrashing-floor. Near his place of work there was a well by the side of which Castellan had vomited several times. It is this well that supplies the quarter where there was the greatest number of cases.

But this is not all. Following a storm of the 4th of September, a well previously dry situated on the road to Italy, was afterwards filled with water supplied by infiltrations from the town. From the 6th of September, in this quarter, cases broke out among the inhabitants, who, on account of the scarcity of water, had hastened to supply themselves at this well, the water of which there was certainly good reason to suspect.

#### THE CHOLERA AT PRADES.†

The first case which appeared at Prades was that of a child from Boule-Ternère. This child went to live in the hotel Palot at Prades, on the Route Nationale, where it died shortly after. We must add that on arriving there it showed manifest symptoms of cholera.

Immediately after its death the epidemic broke out at Prades, but limited itself to a quarter bounded on one side by Perou street and its prolongations, Belfort and Hospice streets, and on the other streets by the Route Nationale, at the place where it is parallel to the rue du Perou. Canigou, Dagobert, and Alsace-Lorraine streets unite these large streets, the first by a rectilinear passage, the others by a long winding course.

The drinking water which supplies this quarter is furnished by (1) The fountain of the Chiens, in rue Hospice. (2) The Salettes wells, rue de Belfort. (3) The Sabater wells, rue du Perou, No. 16. (4) The fountain, Saint-Côme, at the extremity of the rue du Perou. (5) A monumental fountain at the end of the rue de l'Hospice, on the public square of Prades. (6) The numerous private wells in the middle quarter of the Route Nationale.

The Route Nationale, or grand route, straight and parallel to the rue du Perou at the beginning (from No. 1 to 45), makes a bend in the middle (from No. 45 to 65), then becomes straight again further on, which does not concern us.

The Palot hotel, where the child from Boule-Ternère died of cholera, is traversed by an irrigation canal, which, crossing perpendicularly the Route Nationale, divides into two secondary branches, one of which continues the first course and traverses gardens and houses, until it reaches No. 12 of the rue de Belfort. There this branch in turn separates into little streams which flow along the right and left sides of Belfort and Hospice streets and finally empty into the dirty-water sewer of the town. Up at the fountain of the Chiens the waters of this irrigation canal, thus subdivided, filtrate into this fountain, which furnishes only a little water of very bad taste.

\* The Cholera at Brignoles, and report of Dr. Rollandy of Tourves.

† For this very interesting account we are indebted to Dr. H. Nalanda of Prades,



The other branch of the irrigating canal, covered over, passes along the right side of the Route Nationale and receives in so doing the filth of the houses. Opposite Canigou street this branch changes direction, reaches the middle portion of rue du Perou, flows on both sides of this street and supplies the fountain Saint-Côme with its infiltrations.

As we have stated above, the first cholera victim, the child from Boule-Ternère, died at the Palot hotel, which was traversed by the irrigating canal. This canal naturally here received the choleraic dejections thrown in it without precaution, as it later received them from the middle portion of Belfort and Hospice streets on one hand, and of Perou street on the other. We thus see the chances of contamination to which the fountains of the Chiens and Saint-Côme were exposed, subject as they were to the infiltrations of this canal infected throughout its course from the first day of the epidemic.

The wells Salettes and Sabater, and the wells midway along the Route Nationale, and the fountain on the public square were, on the contrary, protected from all contamination.

This being stated, let us see—first, what is the exact distribution of these different drinking waters among the inhabitants of the infected quarter; second, what is the distribution of the cases of cholera in this same quarter.

Dependent upon the Saint-Côme fountain are: (a) in rue du Perou, the houses from No. 61 to No. 17 inclusive, and from about No. 44 to No. 28 inclusive; (b) on the Route Nationale the houses on both sides of the street from the beginning up to No. 45.

Dependent upon the Sabater well are: (a) in the rue du Perou the houses from No. 28 to No. 2, and from No. 15 to No. 1; (b) in the rue de Belfort the Nos. 20, 16, 14, and 12 (Nos. 22 and 18 are supplied from another source, as we will see later), and the odd numbers from 27 to 19.

Dependent upon the Saletes well are: (a) in rue de Belfort the inhabitants of Nos. 1, 2, 3, 5, and 7 (No. 7 is supplied at the fountain of the Chiens and by the Salettes well; we will have more to say upon this point.) (b) in Alsace-Lorraine street, No. 6; (c) in rue de l'Hospice, No. 42.

Dependent upon the fountain of the Chiens are: (a) in rue de Belfort, Nos. 24, 22, 18, 10, 8, 6, and 4, and on the other side the odd numbers from 17 to 5, inclusive; (b) in the rue de l'Hospice, Nos. 40 to 30, and 41 to 27.

Dependent upon the fountain of the public square of Prades are the houses of the rue de l'Hospice of even numbers all above 30, and of odd numbers all above 27.

Finally, the well near the middle of the Route Nationale supplies that locality, that is, from No. 45 to No. 65.

Now that we know the water distribution in the infected quarters, observe the distribution of cases in this quarter:

(1) *Route Nationale*.—There was not a single case beyond No. 45. All occurred from No. 1 to 45, that is to say, among the inhabitants supplied by the Saint-Côme fountain.

(2) *Rue de Perou*.—On the even side of the street all the cases are between the Nos. 44 and 32; on the odd side they are all between 61 and 17; that is, the cholera stops exactly at the limit of the water distribution of the Saint-Côme fountain. The rest of the street is supplied by the Sabater well. Yet in this exempted locality we see a case at No. 24. Why this exception? Because the proprietors of this house, 24, having quarreled with the proprietors of the Sabater well, supplied themselves with water from the fountain Saint-Côme.

(3) *Rue de Belfort*.—The only houses attacked on the even side of the street are Nos. 22 and 18, supplied by the fountain of the Chiens; the other houses, 20, 16, 14, etc., supplied from the Sabater and Saletes wells, are spared.

On the opposite side, from 27 to 19, that is, among the inhabitants supplied from the Sabater well, there was not a single case. From 17 to 9, on the contrary (houses supplied by the fountain of the Chiens), each house has a case.

Nos. 7, 5, 3, and 1 are supplied at the Salettes well. They are exempt with the exception of No. 7; but in this house there were two families, one of which was supplied at the Saletes well and was exempt, and the other supplied at the fountain of the Chiens. In the latter the house-keeper had the cholera.

(4) *Rue de l'Hospice*.—From 40 to 30 and from 41 to 31 there were some cases (houses supplied at the fountain of the Chiens); but beyond these numbers there was not a single case (houses supplied by the fountain on the public square).

## THE EPIDEMIC AT VOGUE.\*

The epidemic at Vogue, one of the largest cholera foci of Ardèche, since the mortality there was 66 per thousand inhabitants, presents a succession of hot-beds and exempted quarters that again demonstrate the rôle played by infected drinking water, the hot-beds corresponding with the use of infected water and the exempted quarters being those supplied with irreproachable water.

There is at Vogue an active focus, the center of which is below the château, in the quarter traversed by Esparret alley. All the houses bordering on that alley or little street have one or more cases.

A second focus less important is at the little hamlet of the Granges.

Three quarters, in the neighborhood of the intense focus, have remained remarkably exempt: The quarter of the Pont and the Église, the hamlet of the Bannes, on the right bank of the Ardèche, and the quarter of the Gare.

Now let us see what water the inhabitants of the quarter of the Esparret drank. The large majority got their water:

First. At the Labrot well L.

Second. At the well C.

Third. At the Moulin spring S.

The soil of the village of Vogue is traversed by subterranean passages of very ancient construction, over which several houses are constructed. All the subterranean passages, which are really sewers, open into the Ardèche.

The first of these subterranean streams is formed by the stream Vialore, whose source is the well Vialore, which, on account of the infection of the water, was abandoned by the inhabitants.

The second subterranean passage receives water from the Labrot well L. This passage is in many places a veritable public privy and the receptacle of all the dirty water of the houses along its course. A short distance from the Labrot well is a filthy pool.

The third subterranean sewer, less dirty, passes beside the well C.

The rain-water descending from the hills and higher quarters of the village sweeps before it the filth of the dung-hills. The public wells V, L, C, are exposed to danger from proximity of these subterranean passages transformed into sewers. When one meditates that the practice of disinfection, and the smallest precautions regarding dejections, were quite as unknown to the inhabitants of Vogue during the epidemic as common cleanliness in ordinary times, one can understand how many choleraic germs the waters of these wells must have contained.

The little hamlet of Granges, which out of 30 inhabitants had 1 mortal case of cholera and a dozen of cholerine, is supplied with water for the most part from the well C, mostly uncovered, only 3 meters deep, and flanked by a stone trough.

Before reciting the exempted quarters we must say a word of the little foci located at the houses 1, 2, and 3, on the right bank of the Ardèche, between the Gare quarter and the principal focus. House 1 is habited by a family of six persons. The grandmother, who at the beginning of the epidemic went daily to Vogues to nurse her daughter, who had been attacked by cholera, fell sick in turn on the 10th of August. Her dejections were thrown into the pig-pen, where was also thrown the water used in household duties.

All this water and filth is carried by the rain-water into a little stream which empties into a hole in the alluvial deposits on the border of the Ardèche. This hole is scarcely 2 meters from the Charron well, supplied by infiltrations from the Ardèche and Auzon.

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\* According to Bouveret. Choleraic hot-beds of the Ardèche,



It rained the 7th, 12th, 13th, and 15th of August, and all the filth of the house No. 1, added to the choleraic dejections, was carried towards the hole. It could not be denied that the Charron well would be infected in this manner. Now, three houses were supplied with water from the Charron well, viz, Nos. 1, 2, and 3. In house No. 1, besides the grandmother, there were three more cases on the 15th, 16th, and 19th, one of which was fatal.

In the house No. 2, on the 7th of August (that is before the first case in No. 1 and the infection of the Charron well), the cholera attacked one of the three inhabitants.

In the house No. 3, which is only a farm-house, a case also developed the 16th or 17th of August.

We will now pass on to the study of the exempted quarters.

*Gare quarter.*—This quarter recently numbered about 70 inhabitants, a few of whom lodged at the station, but most of them at the neighboring houses. Now, observe the history as to drinking water in this locality.

In the house No. 1, on the border of the Ardèche, is established a steam-engine, a force-pump, to conduct the water from the Ardèche to the station. The water is conveyed from the river to the railway station in two large metal pipes and is emptied into a reservoir, perfectly cemented and free from all contamination. From this elevated reservoir the water flows in metal pipes to the station and to the fountain F, where it is drawn off by a tap. During the summer, in order to cool this water, the employés conducted it to the bottom of a deep well, H, by means of a rubber pipe. It was to this well or to the fountain F, that all the inhabitants of the quarter of the Gare came for water supplied under such conditions as to guarantee absolute purity.

The quarter of the Gare was exempted, that is to say, among the inhabitants there was only one case of cholera or of cholera, and that patient was not of the locality originally. We will not say there were absolutely no choleraic cases; but the study of the cases there is instructive. Not one of the attacks originated from the quarter, and none proved contagious.

One employé only of the station had a severe diarrhea, followed by a long convalescence; he alone of all the employés of the station inhabited the Esparret quarter.

The house No. 5 was inhabited by a gate-keeper whose duties necessitated frequent visits to Vogue to the maréchal in the Esparret quarter. The maréchal was one of the first victims of the plague. The gate-keeper was attacked, but the disease did not spread to any of his family; even his wife was exempt, although occupying the same bed. The family of the gate-keeper were supplied with water from a private well, D, constructed by the company at several meters from house No. 5.

The house No. 6 was inhabited by six persons. The husband, E. C., had an intense diarrhea which threw him into a state of remarkable prostration. His choleraic attack was either the result of his visits to Vogue or to the neighboring farm-house No. 9, inhabited by a family of emigrants from Vogue, and the Esparret quarter, who had two of their five members attacked by cholera. There was no privy in the farm-house. The dejections of the cholera patients as well as of the others were thrown into the stable in the rear, behind the cistern which supplied the family with water. E. C., of house No. 6, drank sometimes from this cistern on his return from work, and he was the only one of his family attacked.

*Quarter of the Église and the Pont.*—All the houses of this quarter got drinking water either from the public well T, or at certain wells the water of which presents the same conditions as that of the well T. All these wells are in gardens some distance from the Ardèche; they are supplied by infiltrations from the Ardèche, but the water percolates through a gravel bank of considerable thickness, so that the water is always clear.

Here, as in the Gare quarter, although there have been some cases, they were in persons not of the locality.

The collector of the bridge was carried off on the 7th of August by a rapid attack; his wife and his son were exempt; he had gone and contracted the cholera in a house of the Esparret quarter where the disease caused the death of one of the two inhabitants.

Another, A. C., came and died in the Pont quarter, who was brought there from the Esparret quarter.

*Hamlet of the Bannes.*—This is a little hamlet of 60 or 70 inhabitants, which received 14 emigrants from Vogue with linen and utensils; there was not a single case at Bannes. The water is supplied exclusively from a flowing fountain; it descends from a hill 500 meters distant, is brought to the hamlet in perfectly closed earthen pipes, and is distributed by means of a tap.

“Therefore,” and we borrow this résumé literally from M. Bouvert, who has already furnished us almost the entire account relative to the epidemic at Vogue, “a large hot-bed is established in the population between the château and the road; a hot-bed, the center of which is the little street of Esparret. All the inhabitants of this decimated quarter get their drinking water from the pump C, the well L, and the mill-spring S, and a few at certain little wells, A, B, D. Now the location of these most frequented wells and springs, C, L, S, is such that they are exposed certainly to the chance of contamination. Beside this large hot-bed are three well-established exemptions: the Gare quarter, the quarter of the Église and the Pont, and the hamlet of Bannes. These three exemptions correspond with three supplies of drinking water, less exposed (pipe water of the station, well of the Pont quarter), or not exposed at all (running fountain of the Bannes), to the chances of contamination.”

TRANSMISSION BY LINEN AND CLOTHING CONTAMINATED BY CHOLERAIC DEJECTIONS.

In the accounts of choleraic epidemics that we have reviewed it is stated time and again that such a person having, in the course of the epidemic, washed the linen of a cholera patient has been in his turn attacked by the cholera. But this fact is often subject to divers interpretations, for one can always say that, as in a choleraic focus there exist for each individual many ways of being attacked by the cholera, it can never be affirmed exactly what has been the origin of an attack of cholera.

The data that we are going to relate seem to us, on the contrary, to warrant but one conclusion. One factor alone is concerned: Linen soiled by choleraic dejections—its exclusive and consequently incontestable action.

A naval surgeon, M. G., dies at Toulon of the cholera. His linen is sent to La Vallette, where they refuse to wash it. It is then forwarded to La Farlede, where the cholera had not yet shown itself; the daughter of the washerwoman, who had assisted her mother, is attacked by cholera and dies. (Dr. Cuneo. Written communication.)

At Solliès-Pont (Var, arrondissement of Toulon), the first case was that of a woman who washed the linen sent from Toulon by her son, who was sojourning in that city, and had been attacked by choleraic symptoms; she was carried off in a few hours.

At Nantes the first case had been that of a Mr. Conn, living in the quarter of the Gare. His linen was given to a washerwoman, the widow D—, who on the 18th of October washes this linen soiled by choleraic dejections. Attacked the 19th; she died the 22d.

At Yport (Lower Seine) there arrived from Cette on the 28th of September, E. Baz, one of those sailors of a Newfoundland boat, the curious history of which we have related in another part of this work.\* The 29th he had his effects in two lots soaked in a tub (he had had an attack of cholera at Cette from which he had completely recovered); in this task he was assisted by his sister-in-law and his brother. The 4th of October his sister-in-law went to the fountain to wash these same effects; in returning she was attacked by all the symptoms of Asiatic cholera and died in a few hours. She had had the diarrhœa since the evening before.

All these facts appear to us conclusive: That to handle and wash linen soiled by cholera dejections is to expose one's self to the cholera; that soiled linen is an agent of transmission.

In all the choleraic epidemics it has been remarked that the washerwomen particularly were attacked; the epidemic of 1884 was not an exception. At Yport, Dr. Gibert notes that “the laundry people have formed a considerable contingent of the cholera patients.”

At Nantes out of 28 women attacked by the cholera and nursed at the quarantine station Saint-Jacques, there are observed eight washerwomen, and six of these died.

\* See Thoinot, l. c.



On the 23d of July there arrived at Porta (Corsica), a country up to then entirely exempt, the Marseilles postman named X—. He had just passed his quarantine of 7 days at the lazaretto of Finocchiarola, where he had had vomiting and diarrhœa, which were completely arrested by a strong dose of opium.

At Porta he stops at the house of his mother-in-law, Catharine N—. On the 23d, the evening of his arrival, this woman opens his trunks, takes out their contents, and dusts everything, putting aside the dirty linen to wash it, which she does the following morning. In the evening of that day, about 10 o'clock, she is attacked with violent colic and dies twenty-six hours after the appearance of the first symptoms.

On the 26th of July at Milhas (Upper Garonne, arrondissement of Saint-Gaudens), far from every epidemic focus, and where up to then had not appeared a case of cholera, there arrive at Mrs. B—'s her husband and two daughters, fleeing from Marseilles back to their own country. One of the girls had at Marseilles nursed in the street where she resided two women who died with cholera. She had been given several vestments which belonged to them. She had put these in a trunk that she brought back to Milhas. Mrs. B— and one of her daughters open this trunk and take out the clothing, handling and washing it. On the 20th both die from a frightful attack of cholera, one at Milhas and the other at Montsaunés.

In these two examples we see great resemblances in every particular; the women open a trunk containing soiled clothing, handle and wash the dirty, contaminated linen; they are attacked by cholera and succumb rapidly.

We will give another instance concerning the question of soiled linen alone: Mrs. R—, the person concerned, simply opened a trunk containing soiled clothing; she handled it but did not wash it, and succumbed from a frightful attack.

On the 28th of July at the hamlet of La Couche, a dependent of the commune of Saint-Michel-des-Prunières, far from the hot-beds of disease in the south, and up to that time exempt, Mrs. R— dies in a few hours. The evening before, the family had received a trunk from Toulon. This trunk had been sent by a relative who, having lost her daughter by cholera, had wished to save some clothing from being burned and had hastily sent it to La Couche in this trunk. The woman R— had opened it and handled the clothing.

We can now formulate in a general way the law of transmission by linen and clothing soiled by choleraic dejections:

To handle in any way such linen or clothing exposes one to an attack of the cholera.

Everything which has belonged to a cholera patient, everything that could be soiled by his dejections, it is needless to say, may be an agent of transmission.

At Roquevaire (Bouches-du-Rhône) on the 23d of July the woman Clotilde O. died. It was the first case and the first death at Roquevaire. They gave her bedding to a poor woman, T. The latter was attacked by cholera and died the 7th of August.

Before terminating this account, we desire to bring to light an incident which struck us and which M. Marey has particularly called our attention to. It is the rapid and even fulminant or lightning form of the cholera which attacks individuals contaminated by contact with soiled linen and effects.

The woman who died at Solliès-Pont (see above) was carried off in a few hours. It was the same with the woman C., the step-sister of Baz, at Yport.

At Porta the woman Catharine N. died in 26 hours; at Milhas the woman B. was carried off in 11 hours—her daughter in 7 hours; the woman R., of La Couche, succumbed rapidly. In this chapter we will mention several other examples of transmission by linen and effects where death was quite as rapid. At Collobrières a woman died in 6 hours; at La Peguère the woman S. succumbed in 14 hours; at Bollène the girl Eliza V. is carried off in 5½ hours. We only know among all the cases that we have discovered two where a fatal issue lingered any length of time, that is, more than 24 hours. It is the cases of the woman D., of Nantes, who, attacked on the 19th of October, did not die until the 23d, and the sister of Eliza V., at Bollène, who, attacked at the same time and exposed by the same means, died only at the end of 10 days in a reactionary period.

*INTERROGATORIES CONCERNING CHOLERA IN FRANCE.*

In order to obtain the results of many personal observations in France for the purpose of analysis and comparison, I prepared the circular of questions, a translation of which appears below, and addressed it to numerous physicians actively engaged in the practice of their profession in the various localities of France visited by the recent epidemic of cholera. These questions embraced many matters of importance concerning the origin and mode of progress of the disease in that country, as well as points having an intimate bearing upon the etiology and prophylaxis of the disease.

Whilst from Spanish physicians similarly applied to an abundance of valuable information was obtained, I regret to have to state that, on the contrary, but little attention was paid in France to these interrogatories, the great majority of the few responses which were made consisting merely of printed pamphlets touching more or less remotely upon one or more of the queries propounded. The following was the form of interrogatory, which, in order to be more intelligible to the average French physician, who possesses only his native tongue, was put into the French language :

*INTERROGATORIES RELATING TO CHOLERA IN FRANCE.*

QUESTIONS RELATIVE TO THE RECENT EPIDEMIC OF CHOLERA APPEARING IN THE TOWN OR VILLAGE OF ———, DEPARTMENT OF ———, FRANCE.

In order to avoid unnecessary repetitions it is desirable that the replies given should have the number corresponding to that of the question.

Particular attention is called to the questions 1, 2, 7 to 11, 18.

If it be impossible to reply to every question please do so to those which are the most convenient.

(1) Was your town attacked by cholera during the last epidemic which ravaged Europe? When and how was the disease introduced?

(2) When and how did the cholera spread and become epidemic?

(3) Was the spread of the disease rapid or gradual?

(4) Did the cholera spread from one or several centers of infection? In what part of the town were these centers situated?

(5) What measures were devised and executed for preventing the introduction of the disease among your population?

(6) What measures were adopted and put into force for preventing the first case from producing an epidemic? The epidemic once begun, what measures were enforced, and at what date?

(7) The source and means of supply of drinking water? In what way was this water conducted and distributed? What is the percentage of houses supplied with the public waters? Were the upper stories supplied with this water? Did other means exist for supplying drinking water?

(8) If there were any towns or villages situated along the borders of the stream which furnished the drinking water, above the point of supply, were they or were they not visited by cholera? If they were, at what date and to what extent? What is the name of these towns or villages, and at what distance were they from the point of the water supply? What was the rapidity of the stream during the epidemic?

(9) If there be an irrigation canal, whence proceeded the water which it conveys? Did it pass by other populations before arriving at your town or village? If so, were those places invaded by cholera? At what date, and to what degree? What was the distance, by way of the irrigating canal, to these towns?

(10) What was the character and extension of the public sewers in your town or village, and what was the means used for the removal of the household sewage, especially from the closets? What connection existed between the houses and the public sewers?



(11) Had the introduction and spread of cholera any relation whatever with the supply of drinking water, or with the public sewers, the household sewage or the cess-pools?

(12) In which parts of the town or village was the cholera most felt? What was the condition of the inhabitants in the most infected parts, and what was the state of the public sewers, household drainage, etc., at these points as compared with those in parts which were less attacked by the disease?

(13) What were the meteorological, hygienic, and telluric conditions before, during, and after the epidemic? (This question embraces the nature of the soil and of the sub-soil, of its humidity or dryness, of the state of vegetation, etc.)

(14) What were the daily progress and extent of the cases of cholera in your population, and what was the daily mortality?

(15) Did the preventive measures already mentioned exert an appreciable influence over the course of the epidemic?

(16) What are the other diseases, ordinarily common in the locality, which in some points resembled cholera; and which in the beginning offered some difficulty for a differential diagnosis?

(17) What is the treatment which appeared to be the most efficacious for combating cholera?

(18) If it is within your personal knowledge that any individuals were attacked by cholera the second or third time during the same epidemic, please state the number and detail the circumstances.

(19) What are the results and history of the quarantines, cordons, sanitaires, and fumigations in your town during the period of the cholera epidemics?

(20) What measures have been adopted to prevent the reappearance of cholera next summer, and what improvements were realized as to public hygiene, public water supply and public sewerage?

(21) During the last or the preceding winter did cholera persist in your locality either as isolated cases occurring from time to time, or in the form of a localized epidemic?

(22) What is the total mortality of your population according to the statistics of the last five years classified by the nature of the disease?

(23) If your town has not been invaded by the cholera, or if, on the contrary, it has been one year and not the next, to what do you attribute this immunity?

(24) What has been, approximately, the number of persons who fled your town during the epidemic?

#### RESPONSES TO QUESTIONS CONCERNING CHOLERA IN FRANCE.

Below will be found all of the important responses received from the very numerous French physicians addressed as above. The writer takes this opportunity to express his hearty thanks for the collaboration of the respective authors of these replies, and his high appreciation of the valuable and important information which they contain. Their number is too small to form a basis for general deductions; they are valuable, however, as a supplement to the more or less fragmentary information concerning the cholera in France, contained in the foregoing pages. Their chief value will be, perhaps, as an addendum to the somewhat comprehensive collection of data relating to cholera in Spain obtained in a similar manner. The numbers in the following replies correspond to the numbers of the questions of the interrogatories.

##### BEAUCAIRE, GARD.

#### REPLY TO QUESTIONS RELATIVE TO CHOLERA.

(1) The town of Beaucaire had only a small number of deaths from cholera—15 at most; of this number one person arrived from Marseilles. These were all isolated, occurred especially in individuals weakened by age, by privations, or by excesses in eating, or in the consumption of fruits.

(2) The disease did not present the character of an epidemic.

(5 and 6) I ought to mention as preventive measures adopted: the sweeping of streets and the washing of the same, besides the constant flooding of the gutters. These measures were enforced before the appearance of the few cases of cholera which occurred in July.

(8) Yes, the village of Vallabrègues, situated up stream on the bank of the Rhône, was visited at the same time and the epidemic was there very fatal. This village is 6 kilometers distant. The locality of Vallabrègues is inhabited by basket makers. The basket makers macerate, in the pools full of stagnant water, the strips of wood which they employ in weaving the baskets. I attribute to the emanations arising from these pools the exceptional intensity which the epidemic of cholera showed in this locality.

(9) The canal which waters and supplies the town of Beaucaire with drinking water comes from Gardon and Dessert, two villages up stream supplying them with water only for irrigation of the fields.

(10) Beaucaire does not possess public sewers. The household drainage escapes into the streets. The houses are provided with latrines.

(11) The introduction of cholera among us had no relation to the drinking water.

(12) The section of our town attacked by the cholera was that inhabited by the working classes where the population is most dense and where the houses have no latrines.

(13) The meteorological conditions before, during, and after, were dryness of the atmosphere. The hygienic conditions of the inhabitants were good. The telluric conditions were good, for the pavement of the streets was entirely renewed four years ago.

(16) Diarrhœa, especially cholera infantum, caused by the summer heats.

(23) Beaucaire has been several times visited by cholera, notably in 1833; some cases in 1856. I attribute the immunity observed in 1884 to the slight intensity of the epidemic tendency of the disease.

ANTHOINE DE ———.

BEAUCAIRE, *April 20, 1886.*

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POMÉROLS, HÉRAULT.

REPLY TO QUESTIONS CONCERNING CHOLERA, 1884.

(1) Yes, the accompanying notes are the answer to this question. According to my information there was no direct importation; none of the first attacked were away from the town.

(2) July.

(3) Rapid; all parts of the village were invaded in a few days.

(4) There seemed to be a center of infection right in the center of the village.

(5) Washing of the streets and use of chloride of lime.

(6) Disinfection of the dejecta with sulphate of copper and of the cadavers with corrosive sublimate. The linen and bed clothing of the dead at once burned; burial very prompt.

(7) Well-water and spring-water conducted by a trench.

(8) No; no village along the course of the water supply.

(9) No irrigation canal.

(10) An open sewer; disinfected; receives the greatest portion of the sewage.

(11) No; no.

(12) The accompanying note furnishes the answer. The force of the epidemic fell quite unevenly upon different parts of the village. Hygienic conditions pretty good except of the three first cases.

(13) Good hygiene; public health excellent. The village is healthy, and has always suffered very little from any of the epidemics.

(14) The accompanying note gives the reply.

(15) No.

(16) Sporadic cholera: a few light cases usually every summer.



(17) Opiates at the commencement; opium and belladonna against vomiting; iaudanum against the intestinal disturbances; hypodermic injections of morphia against the cardialgia. In one word, treatment of symptoms. The confidence of the inhabitants enabled me to act almost always early, even in the prodromic period, and contributed much to the happy results obtained.

(18) No; at least not at Pomérols.

(19) None.

(20) None.

(21) No.

(22) Can not reply; the documents unobtainable.

(24) Absolutely no flight. There was complete confidence.

Dr. LOUI L. DESPETIS.

LES YENZES, *April 19, 1886.*

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VERNET-LES-BAINS, PYRÉNÉES-ORIENTALES.

REPLY TO QUESTIONS RELATING TO CHOLERA IN 1884.

I perform a pleasure and at the same time a duty in giving you all the information which I have been able to collect during the cholera epidemic of 1884 at Vernet-les-Bains.

First permit me to make you acquainted with the geographical position of Vernet-les-Bains relative to the places which were visited by the cholera.

Vernet-les-Bains is situated 650 meters above the level of the sea, at the foot of Carrigan, a peak of 2,789 meters altitude,  $0^{\circ}-7'-8''$  east of the meridian of Paris, and  $42^{\circ}-31'-10''$  north latitude. It is 52 kilometers from Perpignan, 10 kilometers from Prades (head of the arrondissement and canton). Surrounded by the communes of Fillols, Carneilla du Côte, northeast, the commune of Vernet is separated from Prades in the direction just indicated by the two other communes of Corinya and Ria. There is, therefore, between Prades and Vernet in the two directions north and northeast the territory of two communes which must be crossed in going from one locality to the other. I must inform you concerning this point in order to show you that the cholera which was at Perpignan and its neighborhood made its first appearance at Vernet and at Prades some days later. The communes which surround Vernet were entirely spared. Vernet has a population of 1,000 besides a floating population of 2,000 who visit the baths. This stated, I recur to your series of questions to which I shall endeavor to respond with as much clearness as possible.

(1) The department of Pyrénées-Orientales has experienced during my lifetime two epidemics of cholera—in 1854 and 1884. Vernet-les-Bains did not have a single case of cholera in 1854. When the cholera of 1884 invaded Toulon, Marseilles, the shores of the Mediterranean towards the Pyrenees, and Perpignan, a large number of persons from those localities came as refugees to Vernet hoping to escape the disease by this change of place. Towards the month of July there arrived from Toulon, four families; from Marseilles, two; from Perpignan, a very large number. Among the persons arrived from Toulon I should mention a young woman who had lost her husband by the cholera. She arrived with an infant at Vernet and went to the house of her brother. She reached here about the first of August, not presenting the slightest symptom of cholera, or seeming to be indisposed in any manner during her sojourn at Vernet which lasted until the month of September. Whilst passing through Perpignan she was disinfected at the station and at the hospital because she came from Toulon, and on account of her husband having had the cholera.

The coachman of a family of Perpignan arrived at Vernet the 15th of August, in the afternoon; during the night of the 15th and 16th he had a very bad cholericine, with vomiting, diarrhoea, cramps, and coldness; reaction took place about 10 o'clock in the morning; on the evening of the 16th he was able to get up and resume his work. On the 16th of August, about 10 o'clock in the morning, just after I had visited the coachman above mentioned, I was called

to see a man of 42 years of age who was suffering with violent colic, vomiting, cramps, coldness, sunken visage, hoarse voice, cold clammy sweat, etc., in a word, all the symptoms of cholera which carried him off on the seventh day. This man had had some diarrhœa for several days. He had eaten the 15th of August, in the morning, a salad, and had gone to the fête of Carneilla where he had eaten and drank more than usual. This was the first case of cholera.

How was it introduced? After the preceding facts I think that we must attribute it to *importation* by persons coming from Toulon or from Perpignan. If this is not entirely certain, it is at least exceedingly probable. In other localities importation has played a very evident rôle. I can cite, first, Baule, where the cholera broke out after the arrival there of a person coming from Toulon; second, Catllar, near Prades, it was also an emigrant from Toulon who brought the disease; third, to Prades it was brought from Baule by a child attacked on the train and taken to a hotel in Prades where it died during the night of its arrival; fourth, Clara received an inhabitant of Estóher who, seized with cholera, dies the day of his arrival. A few days after there were in the locality several fatal cases. This person fled from Estóher where the disease was committing frightful ravages. In one night there had been 20 attacks and 9 deaths in a population of 400 souls.

At the time the cholera appeared at Vernet the epidemic, which seemed to come from the sea towards the mountains, had spread over the whole plain of Roussillon and commenced to enter Conflent. It had invaded Ille, Baule, Rhodès and Vingà whilst ascending the Tet towards Prades. Vingà is 22 kilometers from Vernet. The epidemic which usually marches step by step made a leap from Vingà to Vernet while avoiding Prades, Ria, Villefranche and Carneilla. The disease can have been brought to Vernet only by importation.

(2 and 3) The first case at Vernet occurred on the 16th of August; two days afterwards, the wife and a neighbor of the first attacked are seized; the next day after, the 19th, there are three new cases; on the 23d, 1 case; on the 25th, 2; on the 30th, 1; and on the 3d of September, 1; making a total of 11 cases from the 16th of August to the 3d of September.

(4) The town of Vernet comprises old Vernet and Vernet Ville d'eau. Old Vernet is built in an amphitheater upon a hillock crowned by the church. Around the base of this elevation winds the public road of the department. An imaginary line from the tower of the church to the entrance of the town passes through the center of the epidemic. Six houses at the entrance of the town along the main (public road) street and three others on a neighboring street constitute the sole focus of the epidemic.

(5) Not expecting to have the cholera at Vernet, no precautionary measures had been taken.

(6) After the appearance of the first case of cholera I urged the mayor of Vernet to have the streets cleaned, to have the heaps of manure against the sides of nearly all of the houses, and the fecal matter openly deposited in the narrow streets removed. The streets were watered every day sufficiently for the removal of all kinds of filth thrown into the public streets. I attempted, but not always with success, to cause the removal of the dejecta of cholera patients which were cast upon the manure heaps, or into the streets, or even into the gutters (*rouisseaux*). By quick lime kept in the chamber pots I endeavored to neutralize the dejecta of the cholera patients. After death I caused the cadavers to be disinfected by washing them with a strong solution of corrosive sublimate, and the clothes used by the patients to be immersed in a solution of carbolic acid. Interment was made as soon as possible, five to six hours after death. The bed furniture was burned in the open air and the houses were disinfected with sulphurous acid developed by the burning of sulphur in the middle of the closed rooms. I did my best to counsel the inhabitants of the infected quarter to abandon their houses and remove to a more healthy location. This measure did good through isolation of the houses and raising the morale of the unaffected and healthy population.

(7, 8, 9, 10, 11 and 12) Vernet is supplied abundantly with water brought by pipes in a good condition from a spring of irreproachable quality, fresh, limpid and soft. There are no latrines in old Vernet. It is upon the public streets and upon the numerous manure heaps that the dejecta are deposited. The same disposition is made of the contents of sinks, stables and



pig-styes. Before the epidemic the streets and the garden walks were lined with piles of human ordure exhaling fetid and nauseating odors.

During the months of July and August we had a succession of incessant storms. The rain which descended in sheets carried this filth toward the lower part of the town. As I have already remarked the main public street passes through the town as a sort of elevated dike. This forms a dam for the filth swept down by the rain. This matter accumulated for a long time constitutes a culture medium for microbes of the best kind.

(13) The hill upon which Vernet is built is a mass of iron ore which does not allow of filtration. At the foot of the town beneath the vegetable mold which forms the top soil there is an immense mass of schist with here and there great boulders. A large number of gardens and fruit orchards exist in this locality.

(14) In our small town we had 11 cases and 10 deaths of cholera from the 16th of August to the 3d of September.

(15) I believe that the most efficient measure was the evacuation of the infected focus.

(16) Our locality is very healthy and there are no diseases resembling cholera.

(17) The single patient whom I saved was subjected to purgatives after the fourth day. Most of the other patients had no time to be attended. They died in five to eight hours in the algid stage. Opiates, astringents, ærated and common water were employed.

(18) I am not acquainted with any case of this kind.

(20) I notified the Prefect and even the Minister of Commerce of the existence at Vernet of a focus of infection which ought to be destroyed; there has been no sign of improvement notwithstanding the conditions above pointed out; the summer of 1885 passed without a single case of cholera in spite of the arrival of many Spaniards coming from Valencia and other infected provinces.

(23) The cases of cholera which were observed in certain parts of France were isolated cases and did not present the gravity of an epidemic. At Perpignan and its environs two or three cases of cholera were observed every week during the summer. At Prades, in the month of November, there were a few cases but the epidemic was extinguished before it spread. It was, in vulgar parlance, the tail of the epidemic of 1884.

Although inoculation of the microbe may produce the cholera, I believe other agencies are required for the production of an epidemic of cholera.

U. MASSINA.

VERNET-LES-BAINS, *April* 18, 1886.

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HYÈRES, VAR.

I hasten to address to my honorable confrère, Dr. E. O. Shakespeare, of Philadelphia, the information for which he asked in his letter of April, 1886, concerning the cholera which raged in the city and suburbs of Hyères in 1884-1885.

(1) There were some isolated cases; about 30 in 1884, and 32 in 1885, from mild cholera to the most severe form, fatal in several hours, whilst the disease cruelly ravaged Toulon, distant 18 kilometers, and in uninterrupted communication with Hyères and its suburbs. These cases of cholera could not be considered as having been imported by direct contagion; they developed under the influence of certain unhealthy localities, aided in their action by the medical condition which prevailed then at Toulon, Marseilles, and other towns and villages of Provence, and which must have extended as far as Hyères.

(2) The cholera did not spread and become epidemic, properly speaking, in our city. The cases usually remained isolated.

(3) In 1885, 32 observed cases appeared from time to time during the forty days from August 25th to October 5th. The development of the disease pursued the same slow course in 1884.

(4) Observed cases appeared almost everywhere except in two parts of the lower portion of the town, in the vicinity of the abattoir and along the open canals which received the water of the sewers of the city; here they were more numerous: 4 cases, of which 3 followed by death,

occurred in the same house. Some cases were observed in persons who came from Toulon, but the disease remained isolated and did not spread in the neighborhood, nor even among the inhabitants of the houses occupied by the victims of the disease.

(5) Everything which came from Toulon by rail was submitted to a fumigation of carbolic acid badly and incompletely managed. Travelers were subjected to the same treatment; but nothing was done to persons or things arriving by carriage or foot; no "cordon sanitaire" was established around Hyères; the communication between this city and Toulon remained as free and frequent as ever during the entire time of the epidemic.

(6) From the beginning of the epidemic at Toulon the streets and the squares of Hyères, and the dirty nooks and corners which could be found there, were frequently washed with much water and disinfected with a solution of sulphate of iron, especially in 1884. The houses in which there were deaths from cholera were disinfected, under the care of the police, by means of sulphur.

(7) The city is provided, first, with spring water coming from limestone hills 2 kilometers from the city; second, by ground water drawn from the valley by means of an engine 3 kilometers distant. These different waters are distributed to the public fountains by iron pipes. Very few houses receive directly the water thus transported. Some houses, especially those of the lower part of the town, use well water; it is the same with those situated in gardens and in the valley.

(8) The pipes which supply the drinking water in the city are subterranean. These pipes had no connection with any other town or village.

(9) There is an open irrigation canal (Réal) at Hyères, dating from the fifteenth century, which empties its waters in the river Gapeau, 9 kilometers from the town. This canal serves for a washing place for the inhabitants of the little town of La Crau, 7 kilometers from Hyères, having about 2,500 inhabitants, and for those river-side properties all along its course as far as Hyères. At numerous points the canal receives filth of every nature; vegetable and animal matter of all kinds, refuse of kitchens and even of privies, etc. As it crosses the town it receives two brooks which open freely into it, bringing with them the sewer water proceeding from the upper portion of the town. Leaving the town the waters of the canal (thus contaminated) serve as the washing places for the poor people; other washing places situated above are in positions less unhealthy, although supplied by the waters of the canal. The canal is entirely emptied every week to water the gardens; its waters are entirely fresh. Its bottom is cleaned out once a year, in the spring; it goes without saying its waters are running. The little town of La Crau, which is at the beginning of the canal, has never had a case of cholera.

(10) Bad system of sewerage not having a sufficient slope for the easy running of the impure waters.

The dirty water which is thrown into the streets from the houses returns to the open canals and is conducted to the gardens or to a brook called "le Noubaud;" the water is also used for watering the gardens by means of a high dam.

The fecal matter is received in subterranean pits—very few in number—which are emptied when full; and in portable wooden receivers, for the greatest number, which are removed, when it is needed, and the contents used as manure. Very often they are thrown directly into the gutters of the streets, notwithstanding the municipal prohibition and the surveillance of the police. The principal streets, especially in the inferior quarters, are washed nearly every day with water coming from a steam pump in the valley.

(11) Some cases of cholera observed at Hyères, especially those which occurred in the lower part of the town in the neighborhood of the canals near the sewers, must have been caused from the exhalations from those waters, which were very bad, especially in summer.

(12) The isolated cases of cholera reported in our town occurred here and there without distinction of sex, age, or social standing.

(13) The town of Hyères is built in the form of an amphitheater on the southern slope of a hill principally at its summit composed of a clayey schist mixed with quartz. The sub-



soil in the upper part is very dry, and in the lower part is very damp, especially in the neighborhood of the irrigating canal, where it is impregnated, since time immemorial, with very unhealthy infiltrations. The soil at the edge of the town is alluvium, its least thickness being about 3 feet, resting upon a very compact and impervious base of clay of ocher color. This explains the habitual dampness of the ground, which moreover is kept frequently watered and abundantly supplied by the irrigating canal. The soil is very fertile and very easily cultivated; vegetation is active and very rich. The heights which tower above and surround the town and its suburbs are covered with pines, cork-oaks, and other trees of persistent foliage, which sift and purify the air from the sea, which is about 5 or 6 kilometers from the town. The meteorological observations presented nothing extraordinary or unusual for 1884 and 1885 at Hyères.

(14) About one-third of the cases of cholera reported in this community in 1884 and 1885 were fatal. In 1885, especially, out of 32 cases, light or severe, there were 9 deaths, being 28 per cent.

(15) Nothing appreciable.

(16) It was observed in a large number of the cases of cholera which existed at Hyères during the two seasons of 1884 and 1885, that gastro-intestinal disorders accompanied them; anorexia, dyspepsia, vomiting, and diarrhea. All the confirmed cases of cholera were preceded by these premonitory symptoms, which resulted generally in the beginning of the attack. Apart from the gastro-intestinal disorders, no other disease bears a resemblance to cholera.

(17) For me the evacuants employed at the beginning of the attack, or as soon as possible thereafter, especially ipecacuanha, accompanied by heat and friction, etc., appeared to be the sole efficacious remedy. The seizure once fully established, all the specific or so-called specific and other modes of treatment are equally valuable; that is not worth much.

(18) No recurrence was observed.

(19) No sanitary cordon or quarantine was established at Hyères. In my opinion, the fumigations of carbolic acid—the sole precautionary measure employed in this town—were practiced without discretion by the not very enlightened municipal authorities, without council of the doctors and often in defiance of their advice; and the most stupid and absurd things at Hyères, as well as other places were done. At last these ridiculous means which were employed in such profusion in 1884 were completely abandoned in 1885, going indeed from one extreme to the other, giving up disinfecting, fumigating and every thing else, except washing the streets with pure water. It was not noticed that the sanitary state of the population suffered from this abandonment.

(20) No precautionary measures were adopted for preventing the reappearance of cholera the next summer. In this regard the public hygienic conditions remained in complete *statu quo*.

(21) After the disappearance of cholera in 1884–1885 nothing was observed, which in any way resembled that disease; to-day, the 15th of April, 1886, the general health is excellent in Hyères.

(22) According to the census of 1881 the population of Hyères and its suburbs was, in round numbers, 14,000. The statistics show the mortality to be somewhat variable from one year to another. The annual mean of deaths for the period of 10 years, from 1870 to 1879, was 28 per 1,000 of both sexes. The mean for the period of six years following, 1880 to 1885, was 26 per 1,000. It would seem that the cholera had no influence on the general annual mortality of the inhabitants of the town of Hyères during the epidemic of 1884–'85. However, if the calculations were taken for only the four months—July, August, September and October—during which the epidemic raged in these two years, a certain increase in the mortality would be shown, in comparison with the same four months of the two preceding years. Thus for the two years, 1884–'85 combined, the mean of death for these four months was 10 per 1,000, whilst it was 7 per 1,000 for the four months of 1882–'83, during which time no cases of cholera appeared.

(23) Whilst the population of Hyères, contrary to the experience of Toulon, 18 kilometers distant, was only slightly attacked by cholera we can attribute it to the better hygienic conditions of our town than those of Toulon.

(24) No inhabitant left Hyères to escape cholera.

R. CHASSINAR.

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HILLIL, ORAN, ALGERIA.

REPLY TO QUESTIONS CONCERNING THE RECENT EPIDEMIC OF CHOLERA IN THE MIXED COMMUNE OF HILLIL,  
DEPARTMENT OF ORAN, ALGERIA.

(1) The native population (Arabian) alone was attacked with cholera in October, November, and December, 1884. Cholera prevailed 90 kilometers to the west of Oran. Impossible up to the present time to determine how it was introduced.

(2) It spread about the middle of October, and became epidemic in November.

(3) Rapid dissemination.

(4) Three centers of infection. The first upon small hills, at the foot of which flows a canal, of which we shall speak later. The second, distant 10 kilometers from the first, and located in the plain. The third, distant 10 kilometers from the first two, and situated upon a slight elevation. It was remarked that all of the cholera attacks were among natives living in tents, and leading a semi-nomadic existence.

(5) None; for the residences of the Europeans are a considerable distance from the centers of infection.

(6) From the commencement complete isolation of the sick. The tents and the other linen of the attacked were burned on the spot.

(7) The drinking water flowed through an open canal, in which the animals bathed and drank. This water, very much impregnated with bacteria, quickly underwent decomposition. The inhabitants of all the tents invaded by the cholera obtained their water from this canal.

(8) At 8 kilometers towards the origin of this canal cholera raged, carrying off many victims among the Arabs. The infected point was the toll gate of Perrégaux. The first cases (of Hillil) occurred about twelve days after the appearance of the disease at the toll gate of Perrégaux. The place where the natives drank the water of the canal is called Ifafa (mixed commune of Hillil). At the second point of infection, mentioned in No. 4, they drank of the same water, but down stream from Ifafa. At the third point of infection the people did not drink this water, but were located near a tank, which had no communication with the preceding. The water of this tank was used for drinking and the washing of soiled linen.

(9) From the toll gate to Ifafa, by the canal, 9 kilometers. From Ifafa to the lower point above mentioned, still by the canal, 14 kilometers.

(10) No sewers among these people living in the country.

(11) I have always believed that the cholera was spread here by means of the drinking water.

(12) The virulence of the disease was nearly the same in all of the places invaded.

(13) The native population attacked is poor, filthy, absolutely ignorant of the first rules of hygiene. The soil consists of a black, vegetable mold, and the subsoil is argillaceous. In the plain the water is met with at a depth of 3 to 4 meters. At this time the ground was dry and void of vegetation.

(14) During the first week the cholera spread quite rapidly. It remained stationary for twelve days, and then gradually decreased. The mortality varied greatly. The tribe comprises about 1,200 souls. The maximum reached was 10 deaths in twenty-four hours. On certain days there was not a death.

(15) Yes. By the burning of tents and linen, and by the isolation of the sick, the march of the epidemic was impeded.

(16) This country is subject to intermittent fevers of a pernicious type.



(17) No treatment has seemed to me efficacious in the grave cases. Some natives who were lightly attacked, and received no treatment, recovered.

(18) None.

(19) Negative.

(20) The location of the tents of the natives was changed. It is very difficult to do anything more.

(21) No. At the end of December, 1884, the cholera disappeared.

(22) The exact census of this town never having been taken, I formed my opinion upon information obtained upon the spot, and place the number at about 1,200. Impossible to furnish any information concerning the diseases which have prevailed at a former time.

(23) These people have been invaded by cholera only in 1884.

(24) Among the natives visited by cholera none or scarcely any fled the locality.

DR. ALI.

HILLIL, *April* 19, 1886.

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#### SUMMARY CONCERNING CHOLERA IN FRANCE.

As in Egypt, so in France was the exact origin of the initial outbreak doubtful. The first appearance of the epidemic in the latter country, it is now well determined, was in the summer of 1883, and in the city of Marseilles. Its existence there during that year was, however, at the time successfully concealed by connivance of the municipal authorities, the attending physicians and the nurses. Its origin has continued to be shrouded in uncertainty, but it is believed to have been introduced in some manner from Egypt. Towards the end of June, 1884, the first acknowledged outbreak of the recent epidemic in France occurred in the city of Toulon, the great naval station of that country. The origin of the epidemic of 1884 is by the majority of authorities credited to importation from Tonquin by returning French men-of-war, although some respectable authorities are of the opinion either that it came from India, or was a recrudescence of the concealed epidemic of the previous year in Marseilles.

However this may be, the seeds of the disease having once taken firm root in Toulon, the epidemic rapidly established itself in that city and it was not long before Marseilles was invaded, and subsequently many of the larger cities and villages in the various departments of the South of France. It seems to have spread from place to place by means of soiled personal effects, by small water-courses which had become contaminated with choleraic discharges or the washing therein of soiled linen, and by the movements of persons experiencing an active or a latent attack of cholera. By these means the disease reached and found a lodgement in many places in the interior of France, remote from the districts at first affected. But the epidemic nowhere assumed alarming proportions during 1884, in that country, outside of the southern districts first mentioned. In 1885 cholera again spread somewhat extensively in the South of France, but it seems as a rule to have been more controllable, although its visitations there were more widely scattered; among others distant from the Mediterranean, the departments of the Seine and of Finistère felt to some extent the gravity of the disease. The concealed epidemic of Marseilles, in 1883, has already been mentioned. In 1885, Nice, the popular winter resort for invalids and pleasure seekers from all parts of the world, had a visitation of cholera which was also for a considerable time successfully concealed, notwithstanding the now well known fact that there were upwards of 150 cases of cholera, and a considerable number of deaths therefrom, within its limits during the summer of this year, officially registered under all sorts of names denoting disturbances of the intestinal canal. The last week in December of that year, when the writer undertook to investigate the matter, the municipal authorities still refused to acknowledge that an epidemic of cholera had visited the place. For the evidence thereof I was indebted to the honesty and fairness of some of the local physicians, and to the courtesy of the British Consulate, our American Consul, Mr. Hatheway, being a recent incumbent of the office and having no personal knowledge other than the misleading declarations of official notes from the mayoralty.

It was certainly not for the lack of grossly unhygienic circumstances that the cholera did not ravage the greater part of France during 1883, 1884, and 1885. A careful perusal of the section relating to cholera in this country will show very clearly the filthy condition of Toulon, and of many portions of Marseilles. In fact, the disease found no prolonged resting place in any French town where the hygienic conditions were not miserable, where sewerage was not either absent entirely or in a very disgraceful condition, where the most careless disposal of the excreta did not prevail, where the water and sometimes even the food, especially the milk, did not become contaminated with choleraic emanations. In truth, the hygienic conditions in many localities in France, recently visited by cholera, are but little better than those mentioned as prevailing in Egypt. In my opinion, two factors mainly contributed to limit the spread of cholera in that Republic, viz:—

(1) A fairly well organized and directed public health organization under a vigorous, intelligent, departmental and central control, looking to the isolation of infected dwellings and their disinfection, the disinfection or destruction of infected personal effects, observation of those exposed to the contagion, and inspection of railway trains, etc.

(2) A prompt and fairly effective enforcement of those measures of prevention; although the lapses in these particulars were doubtless not very infrequent and sometimes even glaring, yet experience has amply demonstrated that even lax, or only partial enforcement of well conceived measures of prevention is capable of decidedly restraining the spread of Asiatic cholera.

### SECTION 3.

#### INTRODUCTION AND SPREAD OF CHOLERA IN ITALY.

##### *ABSTRACTS OF UNITED STATES CONSULAR REPORTS.*

##### CHOLERA IN THE PROVINCE OF GENOA, 1884.\*

“Cholera suddenly attacked Spezia on August 22, 1884. Sixty-one cases on the 29th; 49 fatal.”

Gloom pervaded Genoa when this news was first broken to the people, for it foreboded dark days to them, and promised no end of family bereavements.

But unexpected and alarming as was its sudden attack on Spezia, the slow progress of the epidemic since the 22d instant appears no less so, for up to the 31st only 139 deaths are reported, 49 of which were recorded on the first day. Excluding, therefore, the first twenty-four hours, the average death-rate daily numbers 13 victims.

This state of affairs is looked upon with satisfaction, and hope, instead of gloom, now beams from the countenances of the people, for it appears to them that the scourge has spent its fury.

The cause of this apparently sudden check is accounted for in this way: Soon after the cholera commenced its deadly work, the sirocco, or African wind, which had been blowing its heated, feverish breath across the Mediterranean for many weeks, and causing deep depression of spirit to all humanity along the Riviera, suddenly gave way before much-needed rain storms and cool northwest winds. Fresh air then fanned plague-stricken Spezia and checked the death-dealing monster.

A brief review of the sanitary condition of this consular district since June 30, 1884, and the reasons assigned for the sudden outbreak of the cholera in Spezia, seem proper here.

It is not believed the authorities in any city in Europe could be more watchful or take more extreme precautions to ward off the epidemic than those in authority in the province of Genoa. The result is that Genoa is in as healthy a state to-day as it is possible for human agency to make it, considering its peculiar construction and its close proximity to the sea. All the precautions used seemed needed, too, for Genoa is the first port of entry in Italy for all vessels cleared from French ports. The result of this watchfulness was that, until the 22d instant,

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\* Report of United States Consul August 30, 1884.



no clear case of cholera could be proven in this district. Report had it, however, that a few isolated cases were found here and there in the province throughout the summer, but it is generally believed the unfortunate ones were more the victims of sunstroke and its consequent evils than of the real epidemic.

#### HOW IT BROKE OUT AT SPEZIA.

Fifty miles from Genoa, along the coast, is the city of Spezia. It has at present a population of about 30,000 inhabitants. Its harbor is one of the finest in the world. Government workshops and the largest arsenal in Italy are located there. As a naval station it is of the utmost importance to the Italian Government. At the outbreak of the cholera in Toulon and Marseilles, Spezia was chosen by the Government as the place to quarantine all Italian fugitives who fled from the stricken French cities. Government vessels were employed to bring those who had not means to pay their way back to their native land.

Those brought to Spezia at the expense of the Italian Government were held on board ship till the days of quarantine expired. Those refugees were counted by the hundred, and continued to be picked up along the French coast at all times. The report is, and it has not been contradicted, that after their days of quarantine expired, those refugees were allowed to take their mattresses and other bedding ashore with them. After landing they disposed of the infected stuff to the highest bidder. Such being the case, it is easy to account for the sudden outbreak of the cholera at Spezia. Another reason is also given, to wit, that many fugitives escaped ashore during the night, and took their infected clothing with them, the quarantine regulations being rather loose at the time, owing to the small guard stationed along the harbor. There is little doubt but these reasons are correct.

#### CHOLERA IN THE CITY OF GENOA, 1884.

In a dispatch from the consulate at Genoa, December 30, 1884, in speaking of the origin of the epidemic of that city, the consul uses the following words:

Experts were appointed to thoroughly investigate the matter, and their verdict is that the spread of the epidemic in all parts of the city was caused by impure water.

As if to add more weight to the verdict, although not officially so reported, it is understood throughout the city that out of 68 cases of cholera during the first three days of its ravages here, there were 61 deaths, and of the 61 victims it was discovered that all had used the water brought from a certain aqueduct. Further, it was proven that before the analysis of the water was made, fish had died in fountains fed from the water-course alluded to.

A brief description of the aqueducts of Genoa and their feeders, and the causes assigned for the impurity of portions of the water, may not be out of place here.

This city is supplied with water from three aqueducts, two of which belong to joint-stock companies, the other to the city. The De Terrari-Gallerie (joint-stock concerns), and the city aqueducts are about 15 miles long, and both are fed from the river Gorgento. The third water-course, the Nicolay aqueduct (joint-stock company), is about 13 miles long, and is supplied by the river Scrivia. The water from the Nicolay is supposed to be the primary cause of the introduction of the cholera into Genoa, and for the following reasons: Near the head of this aqueduct is a village, Busalla, and close by the village between fifteen hundred and two thousand laborers are employed. The men are under the village and excavating a new railroad track; they are described as in a most filthy condition. The cholera broke out in Busalla on the 14th instant, and up to the date of the investigation by experts (heretofore mentioned) there were recorded 25 cases of the cholera and 14 deaths in that village. Inquiry disclosed that nearly all the workingmen, both the sick and the well, had their clothes washed in the Scrivia, a stream which supplies the Nicolay aqueduct.

As soon as the mayor of Genoa—a brave, fearless, and most energetic executive officer—heard of these things, he immediately ordered the Nicolay Company to shut off the water of the Scrivia and to turn the water from the Gorgento into their water-mains. This was not a long nor expensive job, as the two other aqueducts are very close to the Nicolay, but the company refused;

whereupon the mayor caused the work to be done, and had the cost thereof charged to the Nicolay Company. Whether the stopping of the Scrivia water has checked the disease in Genoa or not is something of a conjecture. But one thing is certain, the people praised their energetic mayor for his action in the matter.

In a dispatch of October 28, 1884, the consul at Genoa informs the Department of State that there is now no longer any cholera in the city or province, and he briefly summarizes the manner in which the authorities fought against the entrance of the disease into Genoa, and the stubborn contest they waged until the scourge was driven from the city.

Since the outbreak of the cholera at Toulon and Marseilles a continual purification of streets and alleys, private and public houses, has been kept up—the most powerful disinfectants being used for the purpose—which has made the city all summer, as it is to-day, one grand smelling-bottle of burning sulphur, chlorine, etc. Impure water, or supposed to be so, was shut off from the city; stale fruits and vegetables offered for sale were seized and destroyed; this year's wine crop was not allowed to be brought into Genoa, and all wine shops were forced to be closed at 8 p. m. daily. The rules were rigid in regard to household cleanliness and the use of disinfectants in whitewash, and if the owner of an establishment heeded not the orders of those in authority, the work would still be performed, and at the expense of the proprietor. To-day, without hesitation, the people acknowledge and thank their brave mayor for it; for, had not all these precautions been taken, Genoa would have a more lamentable record than present statistics of the epidemic show.

In a dispatch of September 25, 1885, the consul at Genoa reports that there has not been a case of cholera in this city since last year. A few cases have been reported in the province of Genoa during the last three weeks, and of the few it has been proven beyond all doubt that exposure, filth, and drunkenness played full as serious parts with the victims as the epidemic did.

#### *CHOLERA IN GENOA AND IN LIGURIA, 1884.*

As having a bearing upon the retardation and beneficial restraint placed upon the spread and course of cholera in Northern Italy by the employment of the various more or less imperfect measures including quarantine by land and sea, the following communication by Prof. E. Maragliano to the Scientific Society of Genoa March 10, 1885, is deemed worthy of incorporation here. Moreover, it forms an excellent supplement to the reports of cholera in this district furnished by the United States consul:

It is a painful story that I am going to lay before you, one, however, which may be full of useful instruction if it be heard with impartiality and without prejudice or bias. It is entirely based upon official documents, the results of that inquiry which, I have already had the honor of informing you in my previous communication, I undertook concerning cholera in the various provinces of Italy, aided in this largely by the Government, which permitted me to collect under its authority the documents relating thereto.\*

As has been stated, in the month of June of 1884, the unfortunate epidemic began in the south of France. Notwithstanding that formerly whenever the cholera manifested itself in that country it visited us shortly afterwards, this time we passed over the whole month of June and a great part of July without having any trouble in the city or province of Genoa. The first alarming news reached us on the 19th of June. At Savona a certain Antonio Giraldi, who came from France and who had undergone a quarantine of five days in the lazaretto of Pian di Latte, arrived at that station, suddenly attacked with the disease; he was taken to the lazaretto and died there after a few hours' illness. The authorities of Savona took all of the precautions suggested by science and experience; the patient was isolated during the few hours of his life, and, moreover, all precautions were observed in the interment of the cadaver; all of his effects were burned. This first case was not followed by others. On the 22d of July notice was received from Riomaggiore that the sanitary physician in charge there had reported to the communal authorities and to the Government the outbreak of cholera in that commune.

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\* The results of that official inquiry appear in Chap. VII in discussing quarantine.



Was it really cholera? For myself, I have no doubt of it. It concerned individuals who, as in the first cases, proceeded from infected places or belonged to families coming from France. I mention this doubt, however, upon the nature of the first cases at Riomaggiore in order to have it discussed, because it is the same sort of doubt raised by the first cases of any contagious and epidemic disease whatever which makes headway in a country.

It is objected that the four persons attacked did not die. This objection for those who are not physicians has some force, but we physicians know that this infectious disease may assume various forms, from the simplest, the so-called choleraic diarrhoea, to the gravest, the so-called fulminant cholera; if doubt is possible, it may occur in those forms which are grave, not in the slight forms. The light forms of cholera have for us physicians a characteristic aspect which differentiates them from those acute intestinal catarrhs which are so frequently confounded with cholera. In the latter general disorders the prostration of strength and other disturbances are always proportionate to the quantity of substance which the individual has lost by the alvine discharges. The choleraic diarrhoeas, on the contrary, present a symptomatology, especially as regards the nervous system, disproportionate to the quantity of the evacuations, so that we have individuals who have had an insignificant diarrhoeal discharge and yet present marked disturbances of enervation which for us physicians serve as an index to distinguish the infectious diarrhoea from that which is simply catarrhal. Thus, with patients who come to us with grave and tumultuous symptoms related to the digestive canal there may be a doubt, but when we meet with subjects who are troubled with symptoms which are slight as regards the intestinal functions, but which show a singular depression of the whole nervous system remaining several days, as was the case with those of Riomaggiore, for us physicians doubt is no longer possible. If patients do not die, we ought to congratulate ourselves.

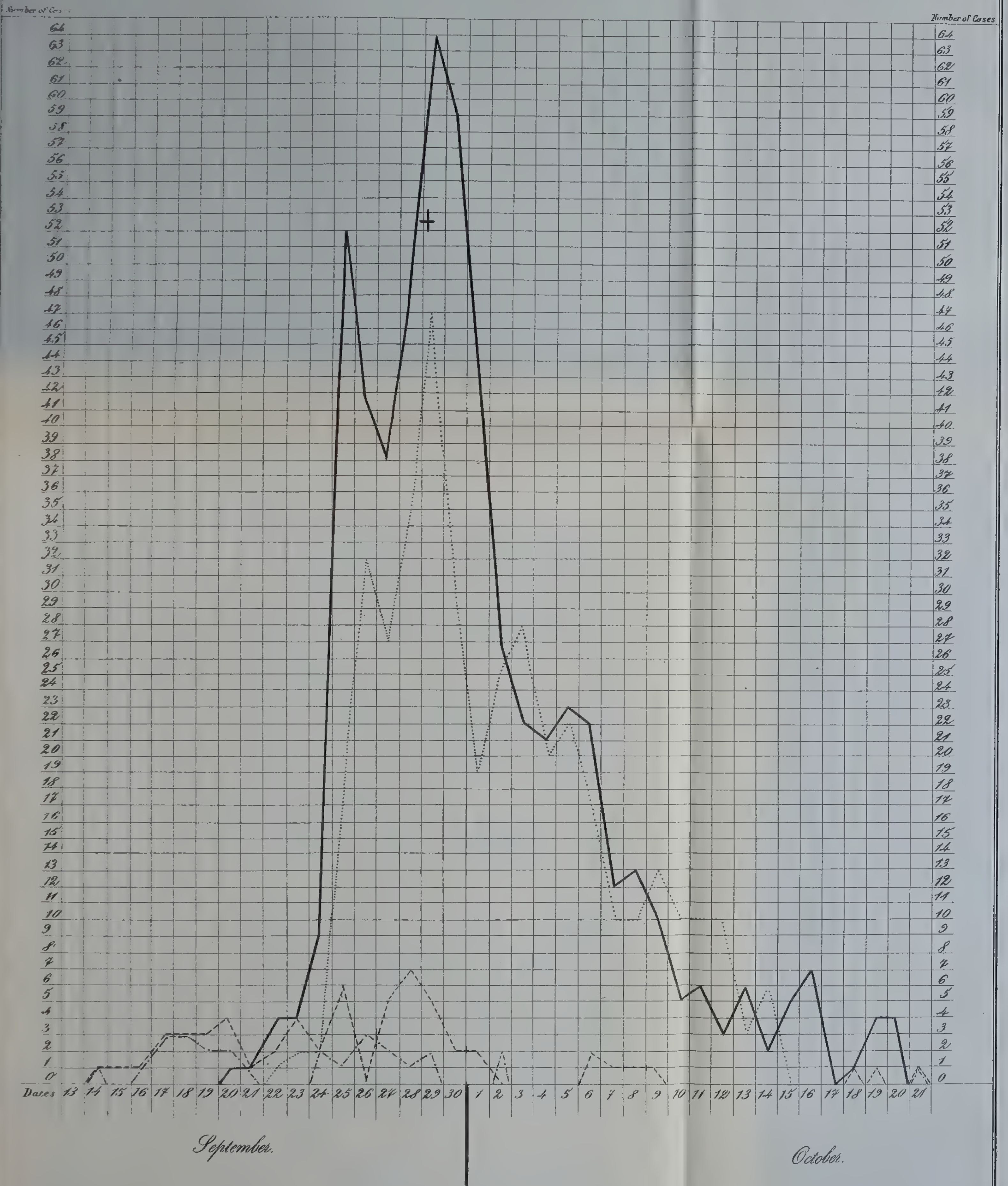
In Riomaggiore there were, moreover, all the conditions for infection. On the 22d of July there were 150 refugees from Toulon, a part of whom returned with their effects during the very first days, when there were no measures of protection established at the frontier. But another objection has been raised. It is said that those cases were not followed by others, and that therefore they could not have been cholera. But this objection has no weight with physicians. We know that when the disease is followed by other attacks it is a sign that the infectious principle has spread throughout the locality, and that it has taken place by common means of diffusion, as for example the drinking water. Here, on the contrary, we had to do with isolated cases developed in those families possessing effects brought from Toulon. The authorities intervened at once, and rigorously, on the first manifestation of those cases. Whoever is acquainted with that locality and knows how limited is its extent will understand how it was possible to disinfect it completely and rapidly. The disinfection was thoroughly performed, house by house and in all the public places, because we had to do in this case with a very small center. Having applied at the very first manifestation of the disease measures thus powerful and energetic, they succeeded in preventing a general infection.

Such were the circumstances under which I was the first to advise the practice of public prophylaxis against cholera, a policy already combated, and against which sentimentalism, and I am willing to admit, also, the thunders of rhetoric were soon hurled. I advised isolation, which, by reason of the topographical conditions of the country, could be done admirably. It was done by cutting off all communication with it except by persons and things which were disinfected, and by influencing the morale of the population who were restive under the hygienic measures which the authorities had imposed, and which, on account of their limited knowledge and small conviction of their beneficial effects, they had not extensively enforced.

After the affair of Riomaggiore, a new occurrence claimed the attention of the Ligurians. On the 30th of July, in Cairo Montenotte, a part of Vignaroli, the disease appeared in a family in which there was a young woman who had acted as nurse in the south of France, and who upon the outbreak there of cholera had returned to her own country. She underwent quarantine at Pian di Latte, but her baggage remained infected. Upon her arrival home she gave some of her effects to a relative, and the latter was the first person attacked with the disease



# The Cholera at Busalla and Genoa during 1884.



Genoa ——— Cases.

Busalla - - - - - Cases.

Deaths.

Deaths.....

The sign + indicates the day on which the Nicolay water was cut off.





Others were infected in such numbers that in a population of about twenty individuals some two-thirds were taken with cholera, and half of them died. This was a matter of grave importance, for there was in that vicinity a camp for military exercise, with four thousand soldiers, and the populous borough of Cairo Montenotte was adjacent to this little village. I did not hesitate an instant, in view of the topographical conditions, which were wonderfully favorable, to advise the establishment of a sanitary cordon. There was not a case of the disease outside the cordon. The survivors, after undergoing quarantine and the burning of all of their effects, were subjected to disinfectant ablutions and were reclothed, and were removed to a distant locality and there encamped. Thus was accomplished a complete cleansing of that locality. In Cairo Montenotte there was not another case.

Thus passed the first twenty days of August, and the Ligurians were enjoying the hope based upon past experience that the danger of invasion was now very slight, when, on the 22d of August, the alarming news arrived of an extensive outbreak of cholera in Spezia. The city of Spezia, from every point of view, was in an extremely unhappy situation. On one side was the commune of Riomaggiore, in which there were considerable numbers of persons returned from the south of France, among whom, as we have seen, some cases of the disease existed, and with whom there was frequent and daily communication; on another side was the lazaretto of Varignano, where large numbers of individuals returned from the south of France were passing quarantine; on still another side was Garfagnana, already infected. As regards the possibility of invasion, the city of Spezia therefore found itself in a very dangerous situation.

From which direction did the disease arrive? From which of the three foci of infection did the infectious germs come? This is a question which it is pretty difficult to answer exactly. Nevertheless I think that by a careful analysis of the facts we can arrive at some quite positive conclusions.

On the 22d of July a suspected case of cholera was reported to the mayor of Spezia. It was in the person of a wandering shoemaker who had been three days in the commune of Riomaggiore, in the house of an individual returned from Toulon—one of those individuals who came on the 23d of July, suffering with cholera, and who gave occasion for the establishment of a sanitary cordon. The evening of the third day he returned to Spezia where he lived. At the station of Riomaggiore he was attacked with the first symptoms of the disease. Arrived in Spezia the symptoms became more severe. He was seen by two physicians, who, on account of the symptoms presented by the patient, did not hesitate to declare that they were treating a case gravely suspected to be cholera. The municipal sanitary commission of Spezia accepted the diagnosis of the two physicians who saw the unfortunate shoemaker, who had died in less than eighteen hours from the first manifestations of the disease, and on account of the death the measures advised were enforced by the communal authorities. I arrived in Spezia after that person had already been interred and his family isolated. I received an account of the symptoms of the disease made by the physicians, and I could but confirm the exactness of the diagnosis of my colleagues. Besides, in the minds of the sanitary council of the district, which had been at once convened, there was no doubt.

It is easy to understand how unpleasant it was to one, upon whom rested the responsibility of the government of Spezia at that critical moment, to announce to all Italy that there at the seat of the first maritime department of the kingdom the Asiatic disease had broken out. Denials were therefore made. The nature of the first case was much discussed, and even such erroneous opinions were published as would be sufficient for me to deny a license to one of my pupils—erroneous opinions which are explicable, however, when we take into account local pride and the desire to cover up lapses which may have been made. Of course a physician does not need to be told that a person seized with such striking symptoms, which reduce a perfectly healthy person to a cadaver in eighteen hours, may have died of invagination of the intestine. It was cholera, and so convinced were they of it in Spezia, that when I arrived there I found the relatives of the deceased confined in quarantine. It is very well understood that the communal authorities at Spezia would not have dared to limit the liberty of the members of the family of a poor deceased person were they not convinced that they were dealing



with a case which required the application of this very stringent measure. At this time, be it well remembered, no case of cholera had yet occurred in the lazaretto of Varignana, nor in the neighborhood of Garfagnana. On the 23d a new case occurred at the island of Palmaria. Concerning this case, it is stated that a mattress was thrown overboard from a steamer which had transported persons returned from Pian di Latte, into the water of the bay, and was taken possession of by the person who was afterward seized with the disease. The captain of the port of Spezia treats of this report in his publications and contradicts it, as he says that he carefully sought to trace this mattress, but could gain no information concerning it. The case of Palmaria therefore can not be attributed to the quarantine station at Varignana, but, on the contrary, we must hold that the person attacked having a considerable trade with Spezia had there received the infecting germs.

On the 1st of August there was a second case, and on the 9th another case in Porto Venere, a part of Vezzano, in a sailor of whom it was not well known whence he came nor what were his communications.

In Spezia on the 12th of August a second case of cholera was officially reported, and then nothing more is said of the disease until the 22d of August, the day upon which 37 cases are reported.

Some have wished to date the invasion by the disease from that day. One who has some experience with the manner in which cholera epidemics are developed easily understands that when a means of general diffusion, such as potable water uniformly distributed, is wanting it is impossible to see the epidemic suddenly break out with such a striking number of cases without being preceded by cases gradually increasing in number. And, in truth, the physicians of the city of Spezia themselves now admit that cases of cholera may have occurred in the preceding days during which some cases of sudden death were reported under the names of sunstroke, meningitis, etc. It is therefore reasonable to believe that the cholera at Spezia began on the 22d of July, and that between the 21st of July and the 22d of August there were cases that were not reported.

I am convinced that neither the communal authorities nor the physicians are to be blamed for this hiatus. It is understood how the public on account of the isolation of the first case were diffident in calling upon the physicians, except in order to prove the occurrence of death. His Majesty's ship *Città di Napoli*, after having transported to the lazaretto of Varignana a large number of persons quarantined in Pian di Latte, and after having undergone twenty-one days of quarantine, was, on the 2d of August, admitted to free pratique. On the evening of the following day, one of the sailors who went to Spezia returned with the first symptoms of the disease, and it is thought that this sailor might have introduced the cholera into Spezia. But it should be remembered that the shoemaker died on the 22d of July. It is more probable that the sailor had, on the contrary, acquired the disease in Spezia, which already existed there in a latent form. It is noted in fact that among the crew of that ship no other case of cholera was observed.

The *Città di Genova*, admitted to free pratique on the 14th of August, is suspected of having brought contaminated clothing to Spezia—an improbable supposition, because it was H. M. ship which had been subjected to quarantine at Varignana, and I myself can testify to the scrupulous care of the medical director of the lazaretto in attending to the disinfection. Neither can I admit the supposition of the departure of this ship from quarantine with contaminated effects. There can be no possible doubt as to the discipline exercised aboard the ships of the royal navy. Furthermore, two days before, on the 12th of August, already the second official case was declared in Spezia in a woman of whom it was uncertain whence she came.

Examining with impartiality the cases in Spezia I believe, therefore, that we can not admit that the infection came from Varignana. The lazaretto may have been somewhat dangerous, but the infection did not come from that side. It is noteworthy, moreover, that there was in the Bay of Spezia a locality which stands in intimate relations with Varignana, the so-called locality of Grazie, in which the families of the attendants of the lazaretto resided; the locality

which furnished the provisions, and with which the lazaretto was in frequent communication by men and things. Nevertheless, at Grazie there was not a case of cholera whilst the lazaretto remained open; if the epidemic could have come from the lazaretto, certainly Grazie should have had the first cases.

It is known how the disease afflicted unfortunate Spezia, which especially suffered in the poor quarters, and it is well known how every one performed his duty, and how the magistrate of that commune nobly paid his debt to the citizens with his own life. You also know that at this time, unadvised by any sanitary body, the Government isolated the city of Spezia on the 26th of August.

I think it opportune to stop here for a moment to examine the results of this cordon from the point of view of the special object which the authorities had in establishing it.

Several communes around Spezia were in the course of time attacked with the disease, viz, those of Lerici, Brugnato, Sarzana, Riccò del Golfo, Vezzano, Borgetto, Vara, Follo, and S. Stefano Magra; but from all the detailed reports which I possess I find that the disease was imported into all of these communes between the 22d, the day of the first outbreak, and the 26th of August, the day on which the cordon was established. After the sanitary cordon was established no neighboring commune was attacked. The few communes in which the germ was already present before the closure of the cordon paid a more or less light tribute to the disease, but all the communes of the Ligurian Riviera remained immune.

It must be admitted, therefore, as regards the protection of the surrounding country, that the sanitary cordon rendered good service. I certainly do not affirm that those inclosed within it received any advantage from it. For those who are unfortunate enough to be thus isolated the cordon is really deplored; but here we enter into a field, the nature of which is entirely humanitarian. This is not an opportune moment to discuss such matters, but it is our duty, nevertheless, to examine the measures adopted from the stand-point of common interests—those which the Government should especially regard. It is certain that a consideration of the injuries which the inclosed may suffer should guide us in the choice of precautions which may enable us to avoid in the future the inconveniences of a rigorous isolation. And this end I believe it may be possible to reach by means of those measures which have been mentioned in the preceding communication, and which it is not necessary to repeat here. At any rate, it is certain that the large focus of Spezia did not cause any damage to our city (Genoa).

It is very true that on the 30th of August Genoa was suddenly invaded, when there were 3 cases of the disease discovered in the suburbs; nor in this case is the suspicion unfounded that the germs may have been imported by a refugee from Spezia, before departure from that city was prohibited. However, the energetic measures adopted by our communal authorities succeeded in extinguishing that focus if it existed, and confidence again returned to our people, engendered by those hygienists who admit that the morbid germ may arrive after it has passed the frontier, but who affirm that, if a locality be found in good hygienic condition, it is possible to extinguish the disease in the beginning.

Notwithstanding so much carefulness and confidence, the disease insidiously invaded our city. On the 14th of September, in the borough of Busalla, there was a case of cholera, which was followed by others. Thus, on the 15th of September, there was a second; on the 16th, a third; on the 17th there were 3; on the 19th 4, and so on, until in a few days among 140,000 inhabitants there occurred 61 cases of the disease. How was the disease imported? When there already existed foci of infection in the provinces of Cuneo and Turin, and travelers were in constant communication with Busalla by the railway trains, the tracing of the arrival of the germs with exactness was not possible. It should be mentioned also that the afflux of workmen from various parts of Italy may have played a part—workmen who, as a mayor writes, were rejected before the issuing of the Morana circular, unless they came from uninfected localities. After the publication of this circular, very falsely interpreted indeed, precautions were no longer taken, and the outbreak of the disease coincided with the arrival of new workmen.



The epidemic of Busalla increased in intensity during the following days, whilst the first confirmed case of cholera occurred in our city on the 21st of September. The curve of the epidemic here rapidly reached its height, for on the fifth day we had 54 cases. The manner in which this unexpected invasion came distinguishes it markedly from those which we have suffered at other times.

The rapid increase of the epidemic is noteworthy in that it reached its acme on the seventh day. In 1835, on the contrary, the greatest number of cases occurred on the twenty-seventh day; in 1837, on the thirty-third; in 1846, on the seventy-sixth; in 1854, on the forty-eighth; in 1857, on the seventy-third; in 1866, on the thirty-seventh; in 1867, on the seventy-eighth; in 1873, on the sixtieth day. In this epidemic (1884) we had the acme of the curve on the seventh day, with 64 cases. Now, it is evident that this rapid mode of ascent is in contrast with the curves of the previous epidemics. But another circumstance which is remarkable is that the disease appeared everywhere. In the previous invasions we saw foci of infection form here and there, and the disease radiate from them—foci which existed in the localities where the population is more dense and where the conditions of life are more deplorable. But this time it was quite the contrary. The disease during the first days not only attacked indifferently the poorest and the richest quarters, but it was also singularly disseminated throughout the whole city. By marking upon a map of Genoa the location of the first 300 cases of cholera, the extension of the disease from the extreme western to the extreme eastern part of the city will be seen at a glance. We find that in the penal Bagno di S. Giuliano, an isolated place where the prisoners are kept in the strictest confinement, there were 5 cases in the first five days of the epidemic; and at the same time the disease made headway upon the heights of S. Benigno at 80 meters above the level of the sea. Meantime, there were attacks in every part of the city, without distinction of the density of population, or of social status, or of hygienic conditions and precautions. It is sufficient to state that the attacks were so disseminated that the first 300 cases were found scattered along one hundred and fifty-eight different streets of the city. Having seen and appreciated these facts, we, who possessed the knowledge that there had occurred here in Genoa no cases of trichinosis (*verminazione*), of insolation, or meningitis to mask the true nature of the mortality—we, who personally saw the cases, and could prove that in the preceding days the ordinary mortality had much decreased, and who saw the disease break out suddenly and attack without distinction of social class or of hygienic conditions, in violation of every law of the spread of the disease up to that time recognized, were obliged to admit that the action of a cause capable of propagating the disease indifferently throughout every part of the city had intervened.

Just here I will allow myself a digression of a purely scientific nature concerning the etiology of cholera, which, as I believe, is involved in this epidemic. It is in these times admitted that drinking water may be made the vehicle of infective germs. We know, for example, that epidemics of measles (*morbillo*), of scarlatina, of typhoid fever, may be justly imputed to contaminated drinking water; and if we consult the treatises on pathology of ten or twenty years ago, although at that period they did not have any exact knowledge of the pathogenic power of micro-organisms, we find it recommended to boil the water in times of epidemics, in order to destroy the more morbid germs which those pathologists held might possibly exist in the water. Lebert, whose ability no one will question, in his monograph on cholera, published twenty years ago, in fact advises boiling water during the epidemic. The hygienists, more especially as regards cholera, took occasion to collect many instances of the importance of the rôle which water may play in the spread of this disease, and Marey, who, during the leisure moments which his physiological studies left him, occupied himself with this subject, has communicated to the Academy of Medicine at Paris a series of facts collected by him, which prove it in a very positive manner of several cities in England, especially London, as well as of some cities in France.

The possibility of the diffusion of the disease by means of the drinking water, already suspected by the earlier pathologists, and already demonstrated by many facts collected by Marey, to-day acquires a greater importance through the discovery by Koch of the cholera

bacillus. I must premise here, that any water whatever may become susceptible of infection, and that there is no longer any difference between good water and bad water in respect to this possibility. The best water may, unfortunately, become infected, just as the most robust person may be infected with cholera; and, on the other hand, it would be absurd to believe that a good water must be always bad because it has been once infected, for any water may be infected only transitorily. The cause of contamination being past, the water may again acquire those qualities which place it among the best. I think it proper to make this statement because it should be well understood that those who hold this scientific opinion, that drinking water can be the vehicle of infection, do not believe that this property is permanent, but, on the contrary, that it is accidental and due to special and transitory conditions.

Given the fact of the possibility of a cholera infection through the drinking water, and remembering the fact that in Genoa a large portion of the potable water is supplied by the Scrivia, it was reasonable to suspect a possible connection between the first outbreak of the disease at Busalla and the rapid and extensive diffusion of the cholera in our city by means of drinking water derived from the Scrivia. In estimating this possibility, we should remember that in Genoa the drinking water is furnished by three aqueducts—by the Civic, by the Galliera, and by the Nicolay. The Nicolay aqueduct furnishes a less quantity than that which is supplied by the other two taken together. Now, on account of the suspicion of a possible connection by means of the Nicolay aqueduct between the appearance of the cholera in Busalla and its rapid and irregular diffusion in our city, investigations were made as to the kind of drinking water used by the persons first attacked. Among the first 50 cases of cholera in our city we found 44 in persons living in houses supplied with Nicolay water; only two persons living in houses supplied by the Civic aqueduct. Of the 50 succeeding cases, we still find 43 dwelling in houses supplied with Nicolay water. In the third group of 50 cases, again, we find 45 in houses furnished with Nicolay water. In fact, this proportion continues in such a manner that of the first 300 cases we find that 93.10 per cent. of the attacked are persons inhabiting houses in which the Nicolay water is distributed, and that less than 7 per cent. were using other water.

Of this class of facts we find still other very striking examples. It is notorious that the poor-house is a very crowded center. Scarcely had the cases of Busalla been heard of when the governing authorities of that institution at once cut off the Nicolay water which supplied it, and not a case of cholera was met with in the numerous population of that institution.

It is well known that near the station of the Western Railway there is a street called *via Bianchetti*. On the right-hand side of *Bianchetti* street the houses are served with Nicolay water, and on the left-hand different water. In the houses on the right, there were cases of cholera; in those on the left there was not a case.

There is still another fact already mentioned, viz, that 5 cases of cholera appeared within five days in the penal *Bagno di S. Giuliano*. Up to that time they had used the Nicolay water for drinking purposes.

We see, moreover, that the disease breaks out and is rapidly disseminated in all the communes in the neighborhood of Genoa which are supplied with drinking water by the Scrivia; only one of them, *Pegli*, escapes. The suspicion was therefore regarded as well founded.

The Nicolay aqueduct obtains its water at a point where the river Scrivia receives a tributary stream in which the clothing of the cholera cases in Busalla was washed. You know that our municipal authorities were apprised of all these circumstances and that they called the attention of the sanitary commission of our commune to this singular coincidence of facts. That commission advised the mayor to prevent for a while the Nicolay water from entering our city. The suspension of the supply of this water was accomplished between the 28th and 29th of September. During the two succeeding days the curve of the epidemic still went up, but then precipitously descended. On the 2d of October, from 64 cases there were not more than 30; from the 2d to the 6th, the number oscillated below 22; on the 7th it fell below 20, after the 9th it did not reach 10 cases, and from the 10th of October the epidemic may be said



to have ceased. There were, however, for ten days, some isolated cases in small number. Between the first case, on the 20th of September, and the last, counting all, we see that the disease did not last more than thirty days, and that the real epidemic did not continue longer than twenty days.

In Genoa the epidemic of 1835, on the contrary, lasted seventy-four days; that of 1836, one hundred and twelve days; that of 1854, one hundred and forty-six days; that of 1855, one hundred and sixty-eight days; that of 1866, seventy-nine days; that of 1867, one hundred and forty-five days; that of 1873, one hundred and twenty-seven days. The duration of the last epidemic (1884) was only twenty days. We see the curve of the epidemic suddenly fall two days after the introduction of the Nicolay water into our city is prohibited. (See the graphic chart constructed from the statistics of cholera in Busalla and Genoa, in relation to the cutting off of the Nicolay water.)

When we consider the special manner in which the epidemic spread among us, we are obliged to hold the conclusions of Marey as exact, and that the experience of Genoa furnishes an important contribution to the scientific doctrine of the possibility of the diffusion of cholera by means of drinking water—a contribution all the more important, as it concerns water flowing in metallic pipes, and therefore not subject to some of the objections made by Pettenkofer, who believes that drinking water is not capable of spreading cholera, but that the disease depends upon the level of the ground-water and the state of moisture of the subsoil. In our case, therefore, the objections of the localistic school of Pettenkofer fall. The experience of Genoa, therefore, assumes a very great scientific importance on account of the proof of the marked decrease of the epidemic after the act which the chief magistrate of the commune had the courage to perform.

Besides Busalla and Genoa, some twenty-four other communes in our neighborhood were attacked. Among them I will name only those which most severely suffered: Sampierdarena Mignanego, Pontedecimo, Sestri Ponente, and Apparizione.

Gentlemen, the invasion by cholera of our peninsula, according to the analysis of the details, may furnish us with further useful information. Above all, it demonstrates to us that the fatalism upon which so many rest after the germs of the disease have penetrated a country, is not justifiable. The experiences in our own province prove that it is not only useful, but indeed necessary to work, and work vigorously; that when there stand at the head of the provincial administration officials with firm hands, who have the intelligence to follow the technical advice of competent bodies, much can be done. That it is possible to extinguish foci of infection is shown by the examples of Cairo Montenotte and Riomaggiore; that it is possible also to render very dangerous foci harmless to a great extent, was proven in the case of Spezia. It teaches us, in fine, how it may be possible to check the spread of the disease from country to country by stringent measures conscientiously adopted, and based, not alone upon theoretical conceptions, but upon practical experience. What we have seen of the epidemic in our province demonstrates to us that, aside from the course pursued by the general Government, the action of the communal authorities may be most useful in extinguishing foci in process of formation. I could mention not a few communes of our province in which the disease was suddenly stamped out, thanks to the energetic measures enforced for the destruction of the germs which had chanced to enter them. Furthermore, the action of the communal authorities has shown us that in communes which can not be regarded as models of hygiene, it is possible to prevent the disease from entering and spreading.

A brilliant proof of how much can be done is furnished by Genoa. Whatever may have been the means of introduction, the infective material was widely spread throughout our city. It must also be admitted that the multiplication and spread of the infection was stopped by such a series of preventive measures that had they not been enforced, the cutting off of the Nicolay water (granting that this was the vehicle of the infective germs) would certainly not have sufficed. The infective germs, once introduced, would have found very favorable soil for their propagation had not the two cardinal measures been enforced, viz, rigorous, constant, continuous isolation of the cases of cholera, and at the same time the most thorough disinfection.

It is advantageous to organize sanitary assistance for the benefit of the attacked, but it should be remembered that measures of assistance are never wanting in a large city. If, however, it should become necessary for the authorities to choose between two things, it is better to select that which is likely to protect the vast majority of the inhabitants still remaining healthy, and adopt those measures which will prevent the sick from infecting the well. It is humanitarian, it is beautiful, it is sublime, to assist the poor patients; but, above all, it is the bounden duty of him who has the care of the public health to prevent the sick from harming the well. And this duty we ought to remember was keenly appreciated by all the authorities of Genoa. The patients and their families were constantly and continuously isolated, and I believe that next to the cutting off of the water we owe it to this measure that the epidemic entirely ceased. Genoa shows in a very clear manner how much one hand, safely guided by a sense of duty, can do in the interest of public health. Our experience proves one thing more, gentlemen. It demonstrates how much damage unwisely-governed, neighboring rural towns can cause a large city. We have seen the carelessness of a rural mayor, or the folly of an ignorant municipal body of a little neighboring village responsible for the infection of great cities and important centers in Italy which had spent vast sums for their protection. The attention of the administrative authorities of all large cities should be called to this fact. This is a question to which another very important one is related, viz, that of the organization of the whole sanitary service of a great Government, which can never efficiently act if this service is not intrusted to a body of competent professional persons located throughout the whole country. When those measures which are necessarily of slow action can not be taken it is certainly incumbent upon the provincial council to observe the greater caution in preventing the rural towns in the neighborhood of large cities from ultimately becoming sources of danger. If at Busalla, for example, the clothing had been washed in public lavatories, instead of in the stream, perhaps Genoa would have escaped, a considerable number of lives been preserved, and the expenditure of vast sums of money been spared.

#### THE OUTBREAK AND COURSE OF CHOLERA IN NAPLES IN 1884.\*

At the time of and during the early period of the cholera in Marseilles there were in that city a number of Italians, among whom were many sailors. During the latter part of July about fifteen of these sailors sailed from Marseilles and landed at Naples. At the time of landing their presence was unknown to the municipal authorities in this city. They took up their abode in the strada di Porto, where they passed one night, after which they were discovered, sent back to their ship, and left as supposed for Palermo. Their stay was sufficient, it is thought, to sow the germs of the disease in that portion of the city where they remained for the single night.

About August 2 the first case of cholera was recorded in Naples for the year 1884, and the patient was removed to the Gonnecchia Hospital, where he subsequently died. From that day the disease made gradual progress, of which there was no official report, the existence of the cases being published by the newspapers in a desultory way, no particular importance being attached to them, seemingly. It was said that the cases were sporadic, and that the disease would not spread, it being too late in the season. On the other hand there were those who said that one of two things might be expected—either that the disease would be smothered for the time being, to break out with renewed force in May, 1885, or that a gradual increase of cases, followed by an outbreak similar to that of 1836-'37, might be looked for.

At last, on August 23, the disease manifested itself in a decided and unequivocal manner. The apparent indifference on the part of the municipal authorities to the cases occurring prior to that date was changed to the greatest activity and anxiety. That portion of the city first exposed to the spread of the disease was the Porto. From there it rapidly extended to the Mercato, Pendino, and Vicaria, the first of which sections rapidly outstripped the Porto in the number of cases and deaths occurring therein, and maintained the foremost position during the period of the pestilence.

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\* Report of U. S. consul, September 22, 1884,



## THE SANITARY CONDITION.

The sanitary condition of the city of Naples, although good in some respects, is rendered uncertain when the outbreak of any disease is imminent which may be intensified by bad drainage.

It is idle to attempt to conceal the fact that the larger portion of this city is sadly deficient in proper drainage. The lower classes of the people are not cleanly, and their personal habits are such as to shock ordinary sensitive natures. When one goes beyond the limits of the wealthier sections of the city into those inhabited by the poor and laboring classes, this is strikingly manifested. The homes of the poor are wretched in the extreme, and it does not seem possible that anything like happiness or domestic comfort can exist among those dwelling in them.

The city of Naples is divided into twelve sections or districts, four of which, viz, the Mercato, Pendino, Vicaria, and Porto, have been those in which the disease has worked the greatest ravages. There were some days during the early part of its course when the better quarters of the city, the San Ferdinando and Chiaja, were free from it, and when it was hoped that at least these sections would escape the cholera, but later all the sections of the city became infected. From these latter-named sections, and many others, the exodus of inhabitants was very great, estimated during the early days of the epidemic at between 50,000 and 60,000 persons. The paths of these refugees lay north toward Rome, Bologna, and Florence; south toward Calabria, Castellamare, Vico Equense, Meta, and Sorrento; and east toward Foggia. Those persons who were left in the city of Naples were of the poorer classes, the tradespeople, those in the employ of the various departments of the Government service, and the employ  es of private business houses, soldiers and seamen, and those entirely dependent for their support upon their daily work. The battle-ground of the physicians was the four sections already named, viz, the Mercato, Porto, Pendino, and Vicaria. These quarters are distinctively old Naples, composed of high, overhanging buildings, into which the direct rays of the sun rarely penetrate in summer and never in winter, containing a population of about 350,000, where the streets are so narrow that one of the small Neapolitan one-horse carriages can not penetrate them, and where the foot-passengers pass each other with difficulty, many of which streets are unpaved and even damp and foul-smelling. In cellar-like rooms, some on a level with the street, and others many steps below, live thousands of the poor of the city, huddled together, ten or fifteen in a single room, without distinction of age or sex, and subsisting upon food of the most miserable and unnutritious quality. The air of these habitations is admitted by the door, and by a small hole in the wall serving as a window.

They live almost entirely upon cheap fruit, bread, and fish, which food lacks the elements necessary to give them power to resist the strain produced upon their enfeebled systems by the cholera. In addition to this they indulge in large quantities of poor wine, which itself has a tendency to cause in them a condition favorable to the development of the disease.

## COURSE OF THE EPIDEMIC OF 1884.

On the 2d day of September, the municipal authorities began the publication of three official bulletins: the first, of cases and deaths from 4 p. m. to 2 a. m.; the second, from 2 a. m. to 10 a. m.; the third, from 10 a. m. to 4 p. m. A list of fresh cases was thus given three times a day; also a list of deaths occurring among those cases in each bulletin, and among the cases published in the previous bulletin.

The bulletins for the first twenty-four hours showed 127 fresh cases and 65 deaths. On the 11th day of September the highest point was reached, the bulletin for the twenty-four hours ending at 4 o'clock p. m. on that day giving 949 fresh cases and 357 deaths. This was followed by 848 fresh cases and 386 deaths on the 12th, and 693 fresh cases and 231 deaths on the 13th, from which date there was a gradual decrease both in cases and deaths.

On September 22 the cases had fallen to 305 and the deaths to 97 within the period of twenty-four hours. The sudden increase in the cases and deaths on the 11th, 12th, and 13th of September, over what they had been previous to those days, is due to three causes.

Monday, September 8, Tuesday, September 9, Wednesday, September 10, and Thursday, September 11, were quite cool though clear days. Friday, September 12, and Saturday, September 13, were very chilly, stormy days. The wind was very high and cool, and the rain fell in torrents at Naples. For the sudden chill that then fell upon the city the people were totally unprepared. Some of them were homeless, and others lived in habitations already cold and damp, and were unprovided with warm coverings and clothing. This class was stricken down by the hundreds. Warm, dry, and sunshiny weather was prayed for as being the only means effectual to reduce the number of cases and deaths; but it was not until Monday, September 15, that the weather cleared and that the sun once more shone forth in a cloudless sky.

Another potent cause of increase was the feast of the *Piedigrotta*, falling on the night of September 7 and the day and night of September 8. In 1883, this bacchanalian fête was celebrated beyond the limits of reason, by the unlimited consumption of fruit, indigestible food, and poor wine. In 1884, the municipal authorities forbade the celebration, but it was found impossible to restrain the people entirely. The fête was celebrated to a certain extent in the orthodox manner, the result of which will be seen in the number of cases and deaths of September 11, 12, and 13.

The third cause of the rapid increase of cases and high death-rate was the fear of and animosity felt toward the physicians by the families and friends of the patients, who believed that they were being poisoned by the order of the Government, already wearied of the large numbers of the poor in Naples. The result was that the cases were either hidden from the authorities until aid came too late, or, if discovered, the people resisted the efforts of the physicians with force and violence.

In addition to this it may be said that there were many cases not reported to the authorities until after death had ensued, before which time distribution had been made of the effects of the deceased among his family and friends, a fruitful source of the propagation of the disease.

It has been found impossible to obtain a correct list of the number of cases and deaths from the commencement of the outbreak to September 22, 1888; but approximately it may be said that over 9,000 persons have been attacked by the cholera in Naples in 1884, 60 per cent. of whom have died.

#### PREVENTIVE MEASURES.

Concerning quarantine, the general opinion is that by sea it may give a certain immunity from the disease if rigorously applied, and in many of the past epidemics the best results have been obtained. No absolute value can be given to the quarantine by land and the sanitary cordons, and it is said that, as far as the latter are concerned, they are only successful in those localities where the population is small and where the ways of communication are few and easy to be guarded. As for fumigation, it is affirmed that in order to be effectual in destroying the germs of cholera the vapors of chlorine or sulphur must be so strong as to be destructive to human life. The means deemed to be the most effectual in preventing the spread of the disease are the removal of the healthy from the infected districts; the absolute isolation of the houses in which the cases occur; the transportation of the sick to a lazaretto of wood, capable of removal, disinfection, or burning, which lazaretto shall have already been prepared for the reception of the sick. The same is said of those brought into quarantine, namely, that the recent arrivals shall be kept separate from those having first come, and furthermore, that the lazaretto shall be located in the lower and not higher places, in order that there may be no infiltration into the healthy quarters.

A disinfecting agent strongly recommended and in use here is a solution of bichloride of mercury (1 to 1,000) to be thrown upon the dejecta. Another is the following:

	Grains.		Grains.
Sulphate of copper .....	50	Carbolic acid .....	10
Corrosive sublimate .....	1	Water .....	1,000

For disinfection in gross, great use is made of a saturated solution of sulphate of iron, to which may succeed the use of carbolic acid, both of which should be employed daily during



the period of the epidemic. It is strongly advised that all linen, clothing, bedding, etc., used during the sickness shall be burned in preference to disinfection, and that all earthen and glass ware used during the sickness should be immersed in chloride of lime and water and then washed in acidulated water. Metal ware should remain for half an hour in boiling salt water (water 100 parts, salt 40 parts).

Considering the intensity of the epidemic in Naples, it seems remarkable that the adjacent towns have not suffered more severely, and especially inasmuch as there has been no quarantine on the mainland, *i. e.*, between the provincial towns. Between Naples and Sorrento there are ten towns of considerable importance, four of which lie within the jurisdiction of this consulate, the rest under that of Castellamare. The former are San Giovanni a Teduccio, Portici, Resina, and Torre del Greco; the latter are Torre Annunciata, Castellamare, Vico Equense, Meta, Piano di Sorrento, and finally we have Sorrento. All of these towns have suffered in a greater or less degree, those most conspicuous being Torre Annunciata, San Giovanni a Teduccio, and Resina.

Since the sudden increase of cases at Naples a fumigation chamber has been established at Castellamare, at the railroad station, and also at the northern entrance to the town of Vico. Having passed through these rooms and having endured fumigation several times, I can speak from actual experience. At Castellamare, on the arrival of the trains, all baggage, large and small, is surrendered and left for fumigation on the outside thereof for two hours. The passengers are then hurried into two large connecting rooms, in the corners of which are earthen dishes, from which rise the fumes of chlorine. In the morning these fumes are strong, in the afternoon mild; after the lapse of seven minutes the passengers are permitted to leave. At Vico it is about the same. Adopting the view of fumigation already expressed, it is clear that the method used is good for nothing, except to thoroughly impregnate one's clothing with the odor of chlorine. It is certainly not this method of disinfection that has saved Castellamare and the other towns from a serious spread of the disease.

At Capri and the other islands in the bay the Government ordered a quarantine of twenty-one days at Nisida, which the Capresi enforced for their island at the muzzle of the gun.

Among the towns whose names have just been given, Torre Annunciata has suffered the most, there having been between 50 and 100 cases; at San Giovanni a Teduccio about 50 cases; at Portici about 30, and at Resina about 40. At Castellamare the cases have not exceeded a dozen; at Vico 3 or 4; at Meta 1, and at Sorrento none. The same proportion of deaths as at Naples has occurred.

What is now the condition of commercial affairs at Naples one may easily imagine. There are thousands of persons here who have no means beyond what their trade brings them, and the question is, how can this mass live? Not only in those quarters of the city in which the disease is the most severe, but in the healthier sections all business has ceased. Either the stores are not opened at all or they open early in the morning and close at noon, for no one enters them for the purpose of buying. The means necessary to meet the obligations of the storekeepers are wanting; their paper must inevitably go to protest, and the daily journals here call upon the Government to make some provision for this industrious class of people to save them from ruin and to extend for a reasonable period the time of payment of commercial paper, for it is claimed that in times of such universal misfortune the Government, in spite of the code of commerce, should have the power and authority to prevent such disaster by measures of prudence and foresight, that the catastrophe may not produce consequences more disastrous than what should naturally follow. It is urged that the Government should consult with the principal institutions lending credit concerning the means to be used to reach the desired end, and that the large banks of Italy should accord to their debtors a reasonable extension of time, say three months.

What the damage has been to Naples by reason of the cholera it is impossible to state at present. Information upon this point must be left for future report. It suffices to say that at present business in this city and province is almost paralyzed.

It can not be denied in good faith that Naples owes its present sufferings, in great measure, to the undesirable condition of the lower classes and to the existence in the nineteenth century

of thickly settled sections which are as they were three hundred years ago. The large proportion of cases and deaths in the Mercato, Porto, Pendino, and Vicaria districts demonstrates this incontestably. These sections have always given the largest contingent of cases and deaths in the epidemics of past years, and always will until some radical change is inaugurated therein. In these sections past epidemics have always had their beginnings, and from these sections has the disease spread to other and healthier regions of the city.

The eyes of King Hubert and his ministers have been opened as they never were before to the true state of affairs among the poor of Naples, and the result may be the opening out of new streets through the four sections, into which the fresh air of the bay and the purifying rays of the sun may enter freely, and as a further result a new system of drainage, not only for these sections of the city, but for the remaining eight.

FURTHER PROGRESS OF CHOLERA IN NAPLES, 1884.\*

Since the last communication the situation at Naples has rapidly improved. It may safely be said that this city has not been so clean in many a day as it is now, nor has the condition of the poorer classes been so comfortable in point of food and drink as it has been since the establishment of the economic kitchens and the contributions in aid of the sufferers, which now amount to about 650,000 francs.

On September 22 the decided and rapid decrease in the cases and deaths began. At the expiration of the twenty-four hours occurring at 4 p. m. there had been 241 cases and 112 deaths. The following table gives the official list from that day until 4 o'clock October 2, 1884:

Date.	Cases.	Deaths.	Date.	Cases.	Deaths.
Sept. 23 .....	243	111	Sept. 28 .....	123	64
24 .....	237	92	29 .....	99	32
25 .....	185	100	30 .....	128	40
26 .....	181	60	Oct. 1 .....	82	28
27 .....	130	51			

These figures, as has been the case with all those published as official during the past month, have been given to the public as those representing the true number of cases and deaths. It can not be said they are given with exactness, for it is well known that during the hours between the night of the 10th of September and that of the 11th nearly 2,800 people died of cholera in Naples. These figures were concealed from the people and were spread over the succeeding days.

To show that this outbreak has been one of terrible severity we recur once more to the list of cases and deaths from August 21 to midnight of September 26, the date at which the diminution was very apparent. From the first-mentioned date to the latter there were recorded in Naples 10,486 cases and 5,548 deaths. Taking into consideration the short period of time between these two dates—thirty-six days—this outbreak surpasses in intensity all those of former years, including that of 1837, as will be seen from inspection of the following table:

Date.	Deaths.	Date.	Deaths.
From Oct. 2 to Dec. 31, 1836 .....	5,300	From Oct. 13 to Dec. 21, 1865 .....	2,200
Apr. 25 to Sept. 25, 1837 .....	13,800	July 30 to Oct. 22, 1866 .....	3,470
July 20 to Sept. 28, 1854 .....	8,600	Aug. 1 to Oct. 7, 1867 .....	300
Aug. 20 to Dec. 14, 1855 .....	1,300	Aug. 22 to Dec. 15, 1873 .....	1,280

As the disease diminished in intensity at Naples an increase was recorded in the suburbs of the city, and particularly at Torre Annunciata, a town containing, at the date of the last census (1881), 17,000 inhabitants. From the 23d of September to the 1st of October there were in that town 128 cases and 70 deaths. These figures are subject to the criticism applicable to Naples.

\* Report of United States Consul, October 2, 1884.



At Castellamare the condition of affairs remains about the same as when last reported. The fumigation at the railway of persons arriving has been discontinued. A few fresh cases are reported daily, but the city is in a satisfactory sanitary condition, due to great care and watchfulness on the part of the authorities.

At Vico, Meta, and Sorrento the health is very good. The latter town is full of strangers, who rest in the security afforded by an almost total isolation from the infected districts.

Thursdays, during October,\* have been observed by the poorer classes as pleasure days. The month of October, in Naples, generally brings most beautiful weather.

On these days the poor and working classes throw aside their work and cares and spend their days and evenings in the country, eating and drinking more plentifully than at ordinary times. Moreover, at this time of the year the vintage is at its height, and the *bettole*, or taverns, have on hand large supplies of the new wine, which is eagerly consumed by the people. In this wine the process of fermentation has not been completed, and copious drinking is usually followed by choleraic symptoms.

In accordance with the customs referred to, half of Naples, that half from the least healthy sections of the city, were in the country Thursday, October 8, scattered about the neighboring villages, eating as they have not eaten for some time past, singing the funeral dirge of the cholera, and drinking the new wine without stint. What was the result within twenty-four hours thereafter? That the new cases rose to 122 and the deaths to 45. It was then that the municipal authorities ordered the *bettole* to be closed on Thursdays in this month, and on Sundays and Mondays.

On the following Sunday the new cases fell to 97 and the deaths to 48, and by October 13 the bulletins recorded only 90 cases and 28 deaths.

This reduction in the cases and deaths brought confidence and relief to all called to Naples daily on business.

The following table is intended to show the population of each of the twelve sections of Naples according to the last census, the number of cases of cholera and deaths therefrom in 1884 down to the 10th of October, and the percentage in every 1,000 inhabitants:

Section.	Population.	Cases.	Deaths.	Percentage in 1,000 about—
S. Ferdinando...	35,758	320	126	3
Chiaja.....	35,495	286	142	4
S. Giuseppe.....	18,405	341	173	9
Montecalvario.....	43,637	463	165	4
Avvocata.....	38,694	350	108	3
Stella.....	40,203	427	165	4
S. C. all' Arena.....	28,079	378	150	5
Vicaria.....	62,359	1,859	943	15
S. Lorenzo.....	20,445	288	118	6
Mercato.....	56,052	3,340	1,590	28
Pendino.....	34,324	1,743	814	23
Porto.....	37,048	1,488	689	18
Total.....	450,499	11,384	5,183	

To the above list of deaths should be added 859 taken from the records of the Conocchia, Maddalena, and Piedigrotta hospitals, occurring from the beginning of the epidemic to midnight of the 10th of October, forming a total of 6,042 deaths.

#### SEWERAGE, WATER SUPPLY, AND HYGIENIC CONDITIONS OF PALERMO.

The United States consul at Palermo, Italy, in a dispatch of February 9, 1885, speaks of the system of sewerage and water supply of that city as follows:

The drainage of Palermo seems to be primitive. It consists of a central and two lateral sewers in the principal streets, the former conveying rain-water, and the latter respectively

\* Report of United States Consul, October 13, 1884.

the accumulated fecal matter and dirty water to the sea. The streets of the second order have but one sewer, in which are carried off the respective ingredients adverted to above, or rather it is intended it should do so. All these are permeable, the contents of one passing out into or through another, thus leaving considerable of their contents in their course; consequent upon which, anxiety has been and is experienced in intelligent and official circles, and wonder is expressed because of the city being so healthy under these circumstances.

Notwithstanding the imperfect drainage, the mortality of Palermo is comparatively small, the deaths between the years 1872 and 1881 being only 26.9 per thousand, and for the last few years even fewer; while the mortality of Rome, Turin, Venice, and Milan was 33.9 per thousand.

The climate of Palermo is temperate but variable. At certain seasons, principally during the winter, the sun shines one minute and the rain falls in torrents the next, or if not rain, hail as large as marbles. Snow has fallen frequently during the present winter, the high hills surrounding the city being covered therewith for two or three months; and yet stoves and fires are almost unknown in Palermo. A Palermetan could not as a rule be induced to live in a house in which there was a fire or a stove, believing either to be fraught with great danger to health, if not to life itself.

The houses in Palermo are generally built without fire-places, grates, or chimneys, so that if a person is desirous of having a fire, he can not. The first winter, therefore, of a foreigner in Palermo is not attended either with comfort or pleasure.

The water used in Palermo is excellent. It is said to be the best in Italy, and is obtained from the hills surrounding the city, to which it is conveyed in open trenches, numerous high water-towers and pumps, thence throughout its entire limits in closed round earthen pipes. The occupants of the top floors in the highest houses are supplied with this water.

The city contains many public fountains at which man and beast can quench their thirst.

The supply of water has, however, been insufficient for some time, and whether this is due to the increase of population or to defects in the pipes, towers, etc., is a problem the authorities are endeavoring to solve.

In 1884 the supply was sufficient to give each inhabitant 300 liters of water per day. According to official data the supply had fallen off in 1872 to 144 liters to each person per day, and a recent estimate has reduced the present supply to 75 liters per day for each inhabitant. In consequence of this diminution, the municipal authorities are causing new pumps to be built with a view of utilizing the low or ground water, which will increase the supply, but it is feared that the quality will not be so good as that derived from the mountains.

With reference to the non-appearance of cholera in Palermo during the recent epidemic in places almost conterminous thereto, the general belief obtains here that the immunity was due to the effective and rigorous quarantine which was at once established and maintained until some time after it was suspended in other places, and every vestige of the disease had disappeared. In support of this belief they quote the epidemics of 1865 and 1873, when the same rigorous measures were adopted and maintained with the same satisfactory results, immunity from the disease; whereas in 1866, when the cholera was prevailing in Naples, insurrectionists from that city broke the quarantine in September of that year, and entered the city of Palermo, when cholera immediately broke out, making considerable havoc among its inhabitants.

From personal observation, I am quite sure that the sanitary condition of the city had little or nothing to do with its escape from the recent contagion. On the contrary, there were many circumstances and conditions which were favorable to an outbreak of the disease in this respect.

Besides the quarantine, other preventive measures, such as disinfection of drains by means of chloride of lime and sulphate of iron, whitewashing the houses of the working classes, etc., rigorous inspection of meat and slaughter-houses, and prohibition of the sale of unripe fruit or suspected food of any kind, were resorted to.



During the various cholera epidemics which have occurred in Palermo, the duration and mortality thereof were as follows :

From June 7 to October 9, 1837, deaths 24,014 ; maximum in one day, 2,000, which is 133.8 per thousand of the population.

From August 10 to November 21, 1854, deaths 5,334, which is 28.6 per thousand of the population; maximum in one day, 365.

From September 20 to December 26, 1866, deaths 3,821; a mortality of 19.7 per thousand of the population. The maximum in one day, 164.

From July 2 to November 13, 1867, there was a mortality of 20.7 per thousand of the population. The maximum number of deaths in one day was 256.

For a history of the invasion of the city of Palermo by cholera in 1885, I can not do better than introduce here the admirable report of the United States consul at that city, Philip Carroll, M. D.\*

#### THE CHOLERA AT PALERMO, 1885.

Cholera appears to be now at an end, no new cases having been reported or known for the last several days, in consequence of which the greater number of those who fled from the city have returned and resumed business. All the stores and shops are again open. Trade is good and everybody seems to be busy and prosperous. Apparently not a vestige of the scourge remains. No one who was not aware of the fact could tell from the appearance or actions of the people that it was so recently in their midst.

In communicating the termination of a disease so dreaded, and usually so destructive to human life, I am pleased to say that the havoc made thereby has been much less than was feared, in view of the apparent imperfect sanitary condition which obtained, and the apathy of the municipal authorities at and previous to its inception.

As stated in previous correspondence, the disease manifested itself on the 7th of September.

On the 19th of November the Italian Government at Rome issued an order abolishing quarantine on vessels sailing from Palermo for other ports in Sicily, thus virtually announcing that the scourge had ceased.

Still there were new cases and deaths on that day, but they were not reported, nor have any new cases or deaths been officially reported since.

The sanitary council discontinued the issue of the daily bulletin of cases and deaths after the 14th of November, so that the cases and deaths after the date adverted to do not appear in the exhibit accompanying this report, but will be submitted in a supplemental statement after the sanitary council shall have made their final report, which, it is believed, will exhibit a great many more cases and deaths than those given to the public during the prevalence of the disease. Indeed, this is within the personal knowledge of the consulate; notwithstanding it is deemed proper to submit the figures furnished daily to the office during the period of the scourge by the sanitary council, as they are official, and consequently entitled to credit.

According to the figures adverted to, there were 4,828 cases of cholera, and 2,614 deaths therefrom, during the epidemic, or from the 7th of September to the 14th of November; the cases and deaths since, as stated, not being reported thus far. Thus it is seen that 54½ per cent. of those reported to have been attacked died.

The disease reached its acme on the 19th of September, 258 cases and 185 deaths occurring on that day, after which, with variations, it slowly decreased to 6 cases and 2 deaths on the 5th of November. From this date no new cases were reported, although the deaths from old cases continued to be reported up to the 14th of the month adverted to.

I now transmit the following for the information of the Department, viz:

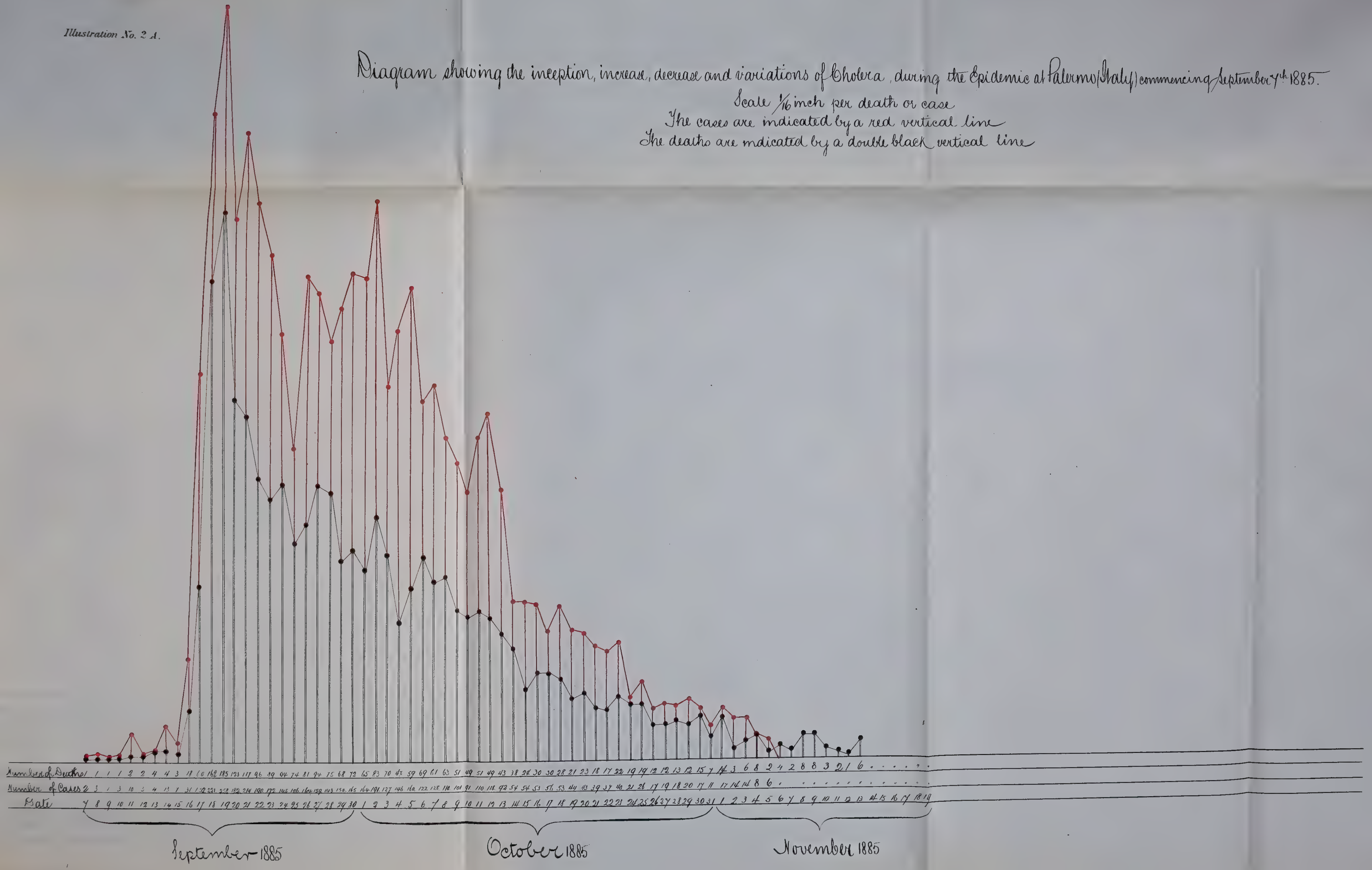
A diagram showing the inception, increase, decrease, and variations of the cholera; a chart of the weather obtaining in Palermo during the prevalence of the scourge, and a map of the valley of Palermo, indicating the various places therein affected by the disease. No. 1

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\* U. S. Consular Report, December 4, 1885.

Diagram showing the inception, increase, decrease and variations of Cholera, during the epidemic at Palermo (Italy) commencing September 7<sup>th</sup> 1885.

Scale  $\frac{1}{16}$  inch per death or case  
The cases are indicated by a red vertical line  
The deaths are indicated by a double black vertical line





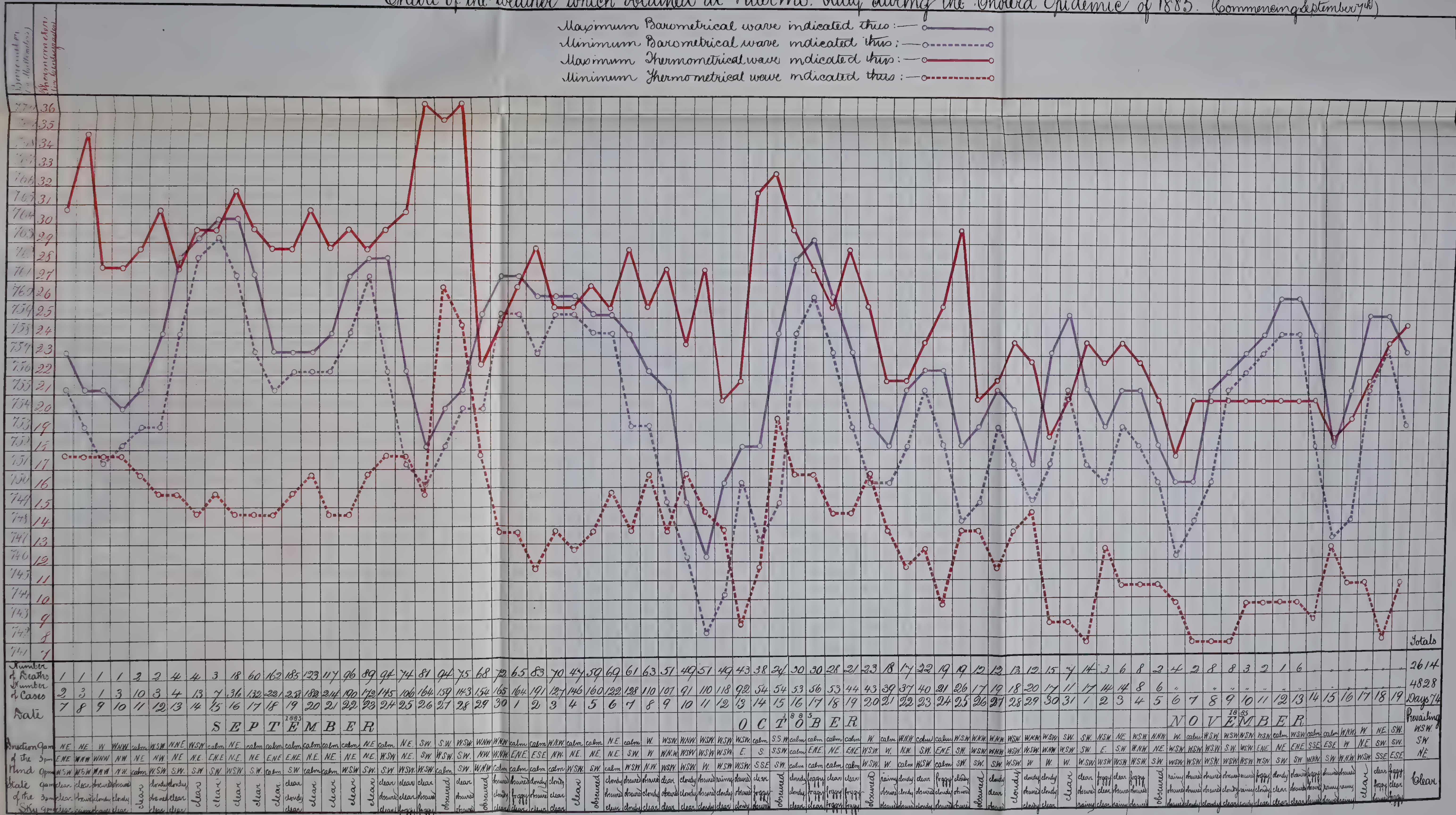




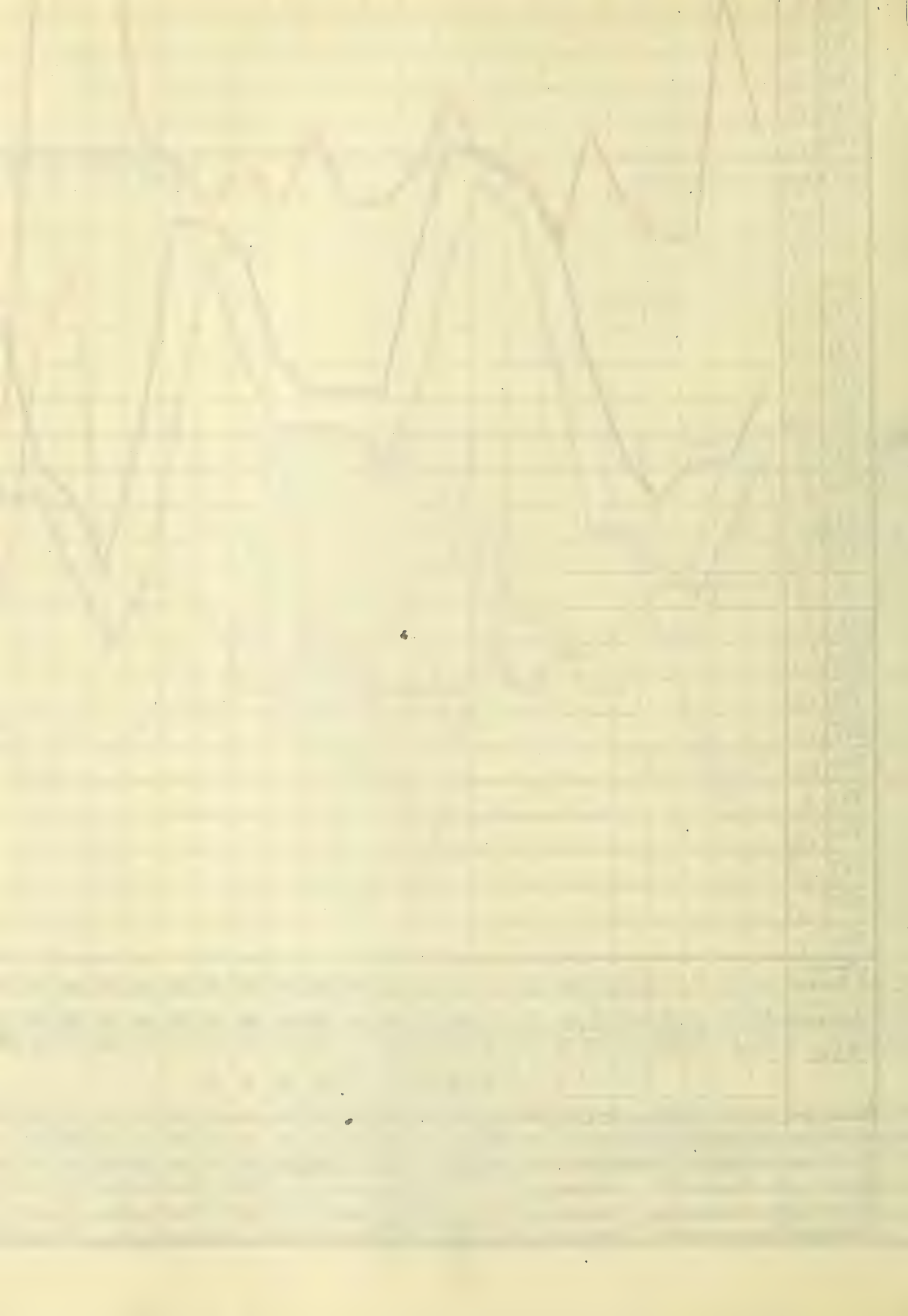
Statement indicating the number of cases and deaths daily, together with a

Chart of the weather which obtained at Palermo, Italy during the Cholera Epidemic of 1885. (commencing September 7th)

Maximum Barometrical wave indicated thus: ————  
 Minimum Barometrical wave indicated thus: - - - - -  
 Maximum Thermometrical wave indicated thus: ————  
 Minimum Thermometrical wave indicated thus: - - - - -



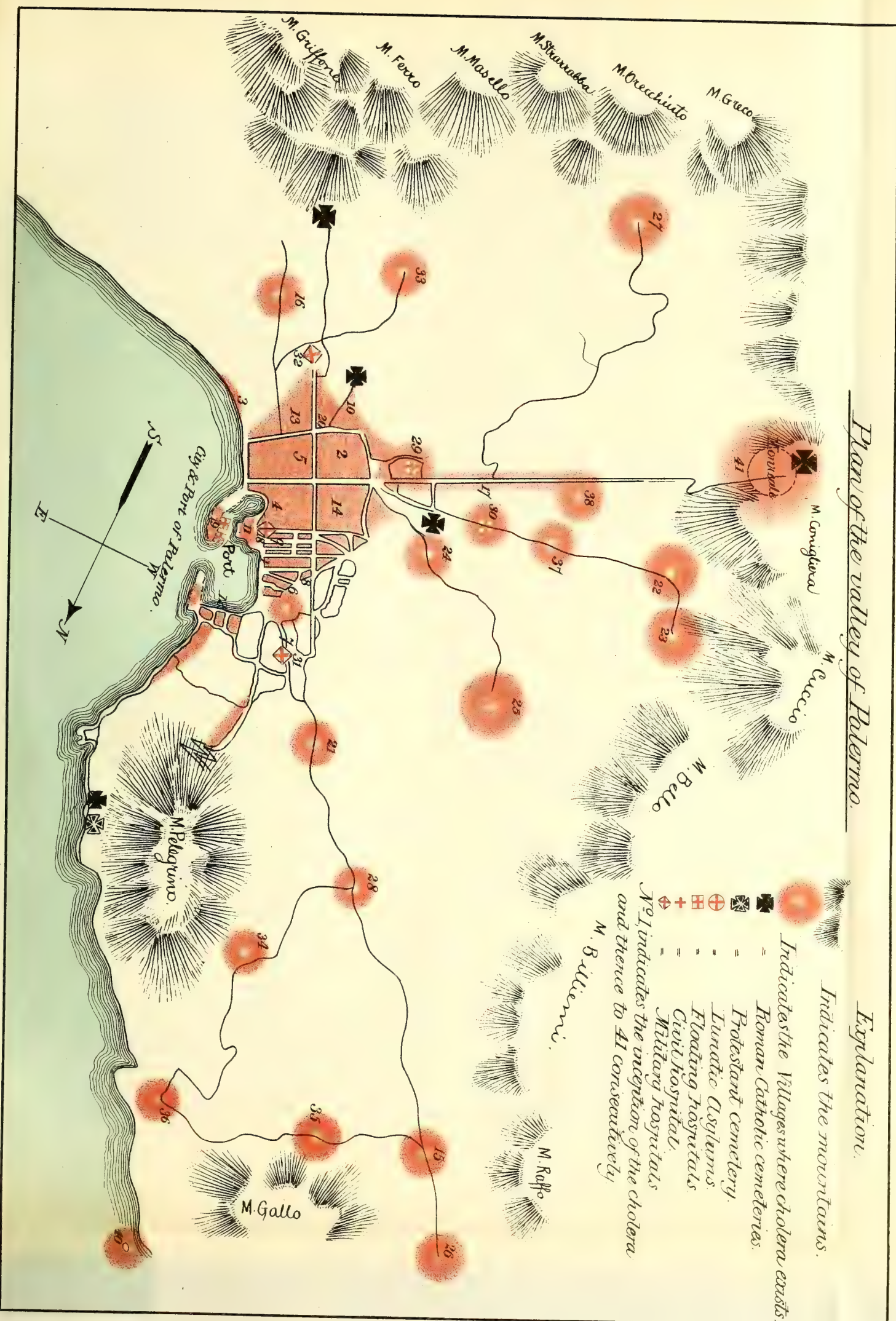




# Plan of the valley of Palermo.

## Explanation.

- Indicates the mountains.
- Indicates the villages where cholera exists.
- Roman Catholic cemeteries.
- Protestant cemetery.
- Funerary Asylum.
- Floating Hospitals.
- Civil Hospital.
- Military Hospitals.
- No. 1 indicates the inception of the cholera and thence to 41 consecutively.







denotes the place where it first manifested itself, and so on, consecutively, to No. 41, where it terminated, within the valley and city.

The procurement and preparation of the data represented in the inclosures referred to were suggested by the knowledge of the numerous and diverse views entertained by gentlemen of equal eminence as to the cause of cholera, and in some cases the conditions favorable to its development and spread. It therefore occurred to me that information of the character in question would be of use, especially as I was not aware of any such record having been kept during previous epidemics, and that it could be utilized by persons who may be desirous of determining as to whether atmospheric or other changes have any effect on the course of the disease.

In each of the representations adverted to, save in the map of the valley of Palermo, the cases and deaths are shown differently, and in each those occurring are represented opposite or over the irrespective dates. This course was pursued in order to make the study of the table and diagrams more simple and easy, and it is hoped it will have that effect.

The predominant state of the sky during the epidemic was clear, and the prevailing winds were WSW., SW., and NE., in the order named.

The highest temperature occurred on the 28th of September, the thermometer ranging on that day 36.7° centigrade, or about 96.80° Fahrenheit. The lowest occurred on the 8th of November, the thermometer indicating a temperature of 7.2° centigrade, or about 44.60 Fahrenheit. The barometer on the days in question marked 755.13, 754.21, 755.20, and 750.25 millimeters, respectively, the second and last numbers being the minimum on the days named.

The cases and deaths on the days adverted to were as follows, viz:

On the 28th of September, 143 cases and 75 deaths, and on the 8th of November, no cases and 8 deaths were reported.

On the 15th of September the barometer indicated 764.30 millimeters, this being the highest point reached during the epidemic, and on the 11th of October it marked 742.40 millimeters, this being the lowest during the period referred to. On the same days the thermometer indicated a maximum of 29.7° and 27.3° centigrade, respectively.

The cases and deaths on the days named were:

On September 15, 7 cases and 3 deaths, and on the 11th of October, 110 cases and 51 deaths.

On the 19th of September, the day on which the greatest number of cases and deaths occurred, the thermometer reached the height of 38.9° centigrade and a minimum of 15.7°, while the thermometer indicated a maximum of 757.27 and a minimum of 756.

By reference to the column indicating the cases and deaths from midday to midnight it will be seen that those occurring during that period were largely in excess of the cases and deaths between midnight and midday.

From these facts, as well as from a careful comparison of the conditions obtaining each day during the epidemic, which can easily be made from the data previously referred to, important deductions seems possible.

The epidemic was managed with skill and efficiency by Professor Albanesi, director of the sanitary council. To his vigorous and intelligent action are due the comparatively light epidemic and early termination thereof.

Immediately upon his appointment he assumed control of everything appertaining to the sanitary affairs of the city, and he exacted obedience to every order emanating from his office.

Dr. Albanesi directed that all wells should be closed in the affected districts, and that the city should be thoroughly disinfected, and especially the more filthy and crowded portions thereof. He also recommended that water should be boiled before being drank, and that all precautions necessary and possible against the disease should be adopted.

Immediately after the closing of the wells the disease commenced to decline, but before this persons from the affected districts who had been attacked fled to other portions of the city in order to hide, and thus escape being taken away by the authorities and placed on one of the



vessels at first employed to isolate persons attacked. Thus the disease was enabled to spread and many new districts and places became contaminated, which were subjected to the same treatment as those originally infected, the wells and open conduits being closed and a guard placed over them to prevent the people from using the water or from washing in the conduits.

Boiled water was generally used by the intelligent people of Palermo during the epidemic. It was used in all the hotels and dining saloons, and it is understood that all who took this precaution, as well as the further one to boil their milk and cook their food well, escaped the disease.

The doctors and nurses appear to have had almost perfect immunity from the disease, only a few of the former having slight attacks, from which they soon recovered. It is understood that one nurse had a violent attack from which she died.

Members of the various aid societies, who were in the midst of it from the start, appear to have had similar immunity. Very few of them were attacked, and only one is known to have died.

The immunity in these cases appears to be due to the observance of the precautions suggested, as well as to their taking care to immerse their hands in water in which was the proper proportion of corrosive sublimate after they had come in contact with a patient and before placing them to their mouths. Corrosive sublimate is said to be the most efficacious article known, so far as killing microbes is concerned, and it was the most popular disinfectant with the authorities during the epidemic. It was used almost exclusively in the hospitals and largely in the streets of the city for this purpose.

The original point of the outbreak of the epidemic is a dirty, filthy locality, crowded by people similar thereto, whose occupations on the male side of the house are those of fishermen and on the female side washerwomen.

It was to similar places that the disease spread, and the more dirty and filthy the place and people the more violent was the disease.

It was noticed during the epidemic that places connected by water or sewerage pipes with the affected districts became contaminated, and that the cutting off of these checked the spread of the disease.

All the recently badly infected places have been condemned by the authorities, and the houses thereon will be speedily razed to the ground.

Cholera was seldom seen in its incipient or first stage during the recent epidemic, and this accounts for—as in all epidemics of this character, I doubt not—the large percentage of deaths of the cases reported.

When cases were seen and treated in the first stage it is understood they generally recovered.

Treatment in the hospitals, depending on the stage of the disease in which the patient was upon entering, consisted of his being placed in blankets which had been thoroughly heated in an apparatus designed for the purpose, and hot appliances placed to his feet, viz, bottles or bricks, or other material. Internally he was given laudanum, ether, or brandy, in doses which might appear at the time proper.

At the homes of the patients, until a doctor was called in, the treatment was on the haphazard principle, and it is known that many of those who were given doses that would certainly and ordinarily kill a person in health, were beneficially affected and ultimately recovered.

In many cases, especially in the early days of the epidemic, the aid societies and others attending to and looking for persons attacked had to taste every medicine administered before the patient could be induced to take a dose. It was therefore a little unpleasant and awkward at times to be engaged in this calling. In fact during the period referred to it was dangerous for doctors and disinfecting parties to go out without a guard, as they were charged by the ignorant people with spreading the disease. This feeling, however, gradually diminished until I think it finally disappeared, and it is now thought that most of the people referred to have been educated up to the efficacy of precautions and prophylactic measures in connection with cholera, and should there be another epidemic there will be little or no trouble in dealing with this class.

The short and lax quarantine of five days which obtained a short time prior to the outbreak of the disease is said to be the cause of the epidemic this year, and it is thought that there is much truth in this, especially when it is considered that an epidemic obtained last year at Naples, a place much nearer Palermo than Marseilles, and yet because of the rigorous quarantine which then existed of twenty-one days it would seem that cholera was kept out of this city. I think no one can be found here who does not believe in the efficacy of quarantine in this connection, and anterior epidemics at Palermo afford ample proof of this being correct.

In the absence of quarantine, or when, from any cause, to maintain one rigorously is impracticable, it is believed that the inhabitants of a community, town, or city would be afforded immunity from an outbreak of the disease if they should sedulously and universally see that all water and milk shall be well boiled before using the same as an aliment, even while in communication with places where epidemics prevail, care always being taken to disinfect ships, rags, etc., coming from infected places. If the above precautions are taken, even if infected persons should enter, an epidemic seems impossible. This view is entertained largely here by persons of experience in the epidemic just terminated as well as in previous epidemics. Together with the above, meat and all food should be well cooked, and bread should be toasted, lest in the handling thereof by various and unknown persons it may become contaminated with the cholera germ.

There is no danger in fruit, ripe, unripe, or decayed, save that which attends it at any time. If it is not contaminated it is impossible that it should produce cholera. Care, however, should be taken to cleanse it well before eating the same. The same applies to all aliments during an epidemic or when it is desired to escape one prevailing at other places.

It seems to be pretty generally understood and accepted, and it certainly seems to be here, that the active agent in the production of cholera is not in the air, and exists in it at no time, and that therefore there is no danger from that quarter; consequently, if the precautions adverted to are observed a person seems as safe in the midst of an epidemic as if none existed. This was demonstrated here during the recent epidemic.

Cholera is dreaded because of its sudden and insidious onslaught and often precipitate and fatal termination. People, when attacked, often succumb because of their complete surrender to the disease, whereas if they kept up courage and fought the disease for an hour or two, and submitted to proper treatment, the chances often are in favor of recovery. The time, it seems, is not far distant when cholera will be less dreaded than typhoid fever, and will be less fatal. I know of persons who were violently attacked by the disease, and who received prompt treatment, being able to attend to business in three hours after the attack.

During the recent epidemic the disease was more prevalent among old people and young children. Many very old people are known to have recovered.

The disease was principally confined to the lower classes, only about 20 of the middle or higher classes being attacked, very few of whom, comparatively, succumbed thereto, which may be attributed to prompt and intelligent treatment and courage of the patient.

Strength seems to have little or nothing to do with combating or contracting the disease, but strength of character and a strong will seem to exercise a strong influence over both. I know of two persons who seemed to have an unlimited lease of life, so far as strength and health were concerned, who succumbed to the disease in three hours after being attacked, and I know of others, whose appearance indicated that they were half dead prior to being attacked, having recovered.

A young boatman, aged twenty-one years, who was in the habit of coming to this consulate, looked the picture of health and strength. Early in the epidemic he was attacked, about 11 o'clock at night, and died before morning. His father and mother, who were also strong and robust, succumbed to the disease soon after, and in less time than their son.

Death, in the last two cases, is believed to have been caused by grief, commingled with fright, more than the effects of cholera.

I know persons who would turn white and shake like a leaf if cholera were mentioned, and as cholera was the sole topic here for months, they had a somewhat unpleasant time. In



fact, it is understood that many such people imagined they had an attack and came near dying.

During the epidemic this office maintained intimate and pleasant relations with the sanitary officials, and it is indebted to them for many courtesies, one of which—and perhaps the most important—is the furnishing, by direction of Dr. Albanesi, of the daily bulletin of cases and deaths, which were sent by special messenger to the consulate every morning. It is understood that this is the only consulate in the city to which this courtesy was extended, but it is also understood that this is the only consulate which solicited the information adverted to, as, of course, it would have been furnished to others had they made the request.

In connection with the diagram, etc., which accompany this report, I am indebted to the services of Mr. William A. Churchill, the efficient clerk to the consulate, for the execution of the same under my immediate direction.

Date.	Cases.		Deaths.		Date.	Cases.		Deaths.	
	Midnight to midday.	Midday to midnight.	Midnight to midday.	Midday to midnight.		Midnight to midday.	Midday to midnight.	Midnight to midday.	Midday to midnight.
Sept. 19	157	101	87	90	Oct. 10	28	63	22	27
20	86	96	58	65	11	42	68	13	38
21	84	130	35	82	12	40	78	17	32
22	82	108	40	56	13	46	46	9	34
23	60	112	45	44	14	18	36	11	27
24	61	84	22	72	15	15	39	9	15
25	35	71	21	53	16	20	33	15	15
26	67	97	22	59	17	18	38	12	15
27	57	102	45	49	18	11	42	5	23
28	52	91	21	54	19	14	30	7	14
29	56	98	24	44	20	9	34	8	15
30	68	97	23	49	21	16	23	10	8
Oct. 1	62	102	25	40	22	13	24	6	11
2	59	132	27	56	23	20	20	6	16
3	53	74	23	47	24	9	12	5	14
4	40	106	12	35	25	6	20	7	12
5	46	114	18	41	26	7	10	6	6
6	38	84	21	48	27	7	12	4	8
7	40	88	15	46	28	6	12	7	6
8					29	5	15	4	8
9	32	69	24	27	30	4	13	4	11

*PREVALENCE OF CHOLERA IN VARIOUS PARTS OF ITALY, 1886.*

*CHOLERA AT GENOA, 1886.\**

For several days past it has been rumored that epidemic cholera exists in this city. The authorities, however, whom I visit daily, will not acknowledge such a state of affairs. The sanitary officers of the mayor's office, as well as those of the prefect's department, deny that cholera in any form exists in Genoa.

On the other hand, Dr. Ferrari, the United States inspector of vessels, an excellent authority, informed me this day that a certain type of the scourge is certainly in the city; but at present it is not certain whether it is sporadic or the Asiatic epidemic.

The doctor added further that Genoa has had fully 35 cases within the past week. His professional opinion is that the cases were, or are, of the sporadic order.

The authorities are believed to be sincere in their views, for all supposed victims of the malady are placed in a general hospital among numerous patients of other diseases, instead of in the lazaretto. This would not be permitted did the health officer suspect the cases were genuine cholera.

\* Report of U. S. Consul, August 26, 1886.

A dispatch of November 13, 1886, from the consul at Genoa, speaking of the outbreak of cholera in Genoa, and of the proclamation that the port is foul, says:

The situation in Genoa to-day is a peculiar one; much excitement prevails; the people are very indignant at the action of the Government, and in this feeling the daily press of the city add still more fuel to the flames of indignation. In this disagreement of mind the local authorities side with the citizens, for they claim in vigorous expressions that all so-called cases of cholera reported are only of the nostras or sporadic order, and not at all contagious. This opinion of the highest officers in Genoa was promptly reported to the Government authorities. Still, in face of such official statement, Rome declared the port foul.

The Caffaro, the leading daily paper in this city, in its issue of November 7, reviews the acts of both Government and local authorities in the following plain language: "The decree of the minister of the interior, in which it is imposed on the authorities to give to ships leaving this port foul bills of health, and which has been avoided up to yesterday, if it has not alarmed, it has surprised our citizens, who are very indignant over such an act. It is the same old inconsistent system that inspires and guides what is called the 'sanitary policy' of the Government, and we stigmatize it as miserable,—worse than that which characterizes all other branches of the public administration."

The consul relates that he made three visits in one day to the offices of the mayor and prefect for information concerning the epidemic, and each time he was sent from one office to the other. Finally, after persistent entreaty, the following statistics were received, accompanied by the emphatic declaration that the number simply represented suspected cases of cholera. From November 5 to 12, inclusive, there had been 118 cases and 73 deaths. It would seem by this that the minister of the interior had just grounds for enforcing the decree of the Government at this port. On the other hand, perhaps it may be interesting to quote the argument advanced by the authorities of the city in justification of their position, as it incidentally describes some of the customs of the people which have an important bearing often upon the spread of epidemic diseases.

Always when new wine is placed on sale here, it is noticeable that the sick-list is increased fully 25 per cent. This season the wine crop was somewhat later than usual. When at its height in the market, three feast days followed one after the other, namely, October 31st, November 1st and 2nd. Work was entirely suspended, and nearly all shops, except saloons, were closed. On the third day of the feast (called here *Defunti*, or Day of all the Dead) thousands of people celebrated it by going to the great cemetery and ornamenting the graves of the departed. Wine was freely used on the occasion with the very light and unsubstantial food on which the people live (a dish composed of vegetables, olive oil, water, and macaroni). It was little to be wondered that diarrhoea followed excessive drinking. To aggravate this state of affairs, the weather for the past fourteen days has been unusually severe. With the exception of one day the rain has fallen in torrents for two weeks. Such extremely boisterous weather has not been known in Genoa for many years. Humanity suffered to a certain extent. People were as prisoners in cold and cheerless rooms, with neither fire nor carpets to give heat or comfort, within solid stone walls and on cold marble floors. Sickness increased.

In a dispatch of November 18, 1886, the consul at Genoa still speaks of the persistence of the authorities in insisting upon the absence of cholera from the port. In the vital statistics from the week ending October 23 to the week ending November 13, appears a total of 67 deaths; but cholera does not figure as one of the causes of death. An examination, however, of the above increase discloses the fact that the mortality in Genoa has nearly doubled since the Government declared the port infected, notwithstanding the fact that the municipal officers ascribe this increase to common causes. The consul reports, from November 12 to 17, 139 cases and 79 deaths of suspected cholera.

#### CHOLERA AT NAPLES, 1886.

The consul at Naples, April 28, 1886, wrote the Department as follows:

I have the honor to report that about the 12th instant the Asiatic cholera made its appearance at Brindisi, on the Adriatic.



After a careful investigation I have ascertained that up to the present time there have been about 100 cases at Brindisi, of which 12 to 15 were fatal. The disease appears in a sporadic form.

In Monopoli only 2 cases followed by death have occurred, without further spread.

Bari has remained entirely clear so far, and it is hoped that the great precautions taken will soon end any further spread of the disease, if not fostered by the setting in of hot weather.

The consul at Naples, September 3, 1886, thus advises the Department:

I have the honor to report that yesterday morning I received information that the cholera had made its appearance at Torre dell' Annunziata, and that there had been 18 cases, 13 of which proved fatal. In accordance with my instructions I reported the fact immediately by cable.

At the same time I requested the sanitary inspector for the United States at this port to make a careful examination of the matter, and I herewith present the result of his investigation. While the cities of San Giovanni, Portici, Resina, Torre del Greco, and Torre dell' Annunziata are separate municipalities, they really form uninterrupted communication with the city of Naples along the eastern shore of the Bay of Naples. I respectfully recommend an extension of the provisions of the instructions of the Department, No. 37, of April 11, 1885, so that they will cover all vessels leaving the Bay of Naples and Salerno for ports in the United States. Very careful medical inspection and strict surveillance have been kept over each and every individual leaving this port for the United States, and will be even more rigidly enforced in the future, but they prove of no avail to prevent the introduction into the United States of persons from the infected districts, for steamers are permitted to take merchandise or passengers at any of the other ports in the Bay of Naples without medical inspection, and I am credibly informed this has been done.

There are at present no cases of cholera reported from the eastern part of this consular district bordering on the Adriatic.

Inclosed with the above dispatch is the following report of Dr. Antonio Fienga, United States medical inspector at the port of Naples, dated September 3, 1886, to wit:

In compliance with your request and my official duties, I have the honor to report the following facts: There have been, within the last two days, cases of cholera numbering in the aggregate 18 at Torre dell' Annunziata, an eminently commercial city, and in continual close communication with Naples, situated on the Gulf of Naples, at about 12 miles from Naples, on the railway from this city to Castellamare and Salerno.

Of the cases reported 13 were followed by death. There have been no cases reported since yesterday. Owing to the energetic remedies and the precautions adopted by the authorities of the said city of Naples it is hoped that the spread of the disease has been checked.

The consul at Naples, on September 11, 1886, reported 121 cases and 61 deaths from cholera at Torre dell' Annunziata, from the 3d to the 11th of September, inclusive, and stated that the Italian authorities are very energetic in their measures to suppress the disease. He mentioned also the existence of a few scattering cases of cholera in the surroundings of Torre dell' Annunziata.

The consul at Naples, September 18, 1886, reported 32 cases and 17 deaths from cholera at Annunziata, from September 11 to 18, inclusive, and mentioned also that during the week 3 cases and 1 death occurred at San Giovanni.

The consul at Naples, November 25, 1886, reported that from the 18th to the 25th of September no cases had been announced in the city of Naples, but that at Torre dell' Annunziata and vicinity there were 27 cases, of which 16 were fatal during that period.

The consul at Naples, October 2, 1886, reported the following: "I have the honor to report that during the week ending this day no cases of cholera have been reported in the city of Naples. At Torre dell' Annunziata and vicinity, during the same period, 44 cases are reported, 22 of which were followed by death."

And in a dispatch of October 9, 1886, he stated that during the week ending that day there had been no cases of cholera reported in the city of Naples, but that at Torre dell' Annunziata and vicinity there were 17 cases and 7 deaths. Torre dell' Annunziata had been declared free.

On October 18, 1886, the consul at Naples reported that since the 9th of October there had been only 2 cases of cholera within the consular district. The quarantine against Annunziata had been abolished.

The consul at Naples, October 28, 1886, reported that during the last ten days there had been no cases of cholera in the city of Naples, but that during the same period there were at Baiia, 3 miles from Naples, 22 cases with 12 deaths, and at San Giovanni, immediately adjoining Naples, 2 cases, both fatal.

On the date of November 6, 1886, the consul reported no cases of cholera in the city of Naples, but at Baiia 16 cases, 14 of which were fatal.

And again, on November 15, the consul stated that there had been no cases of cholera in Naples during the last nine days, while at Baiia there were 6 cases with 5 deaths, besides 2 deaths of persons previously attacked.

The consul at Naples, November 29, 1886, reported that between the 14th and 20th instants there had occurred the following cases of cholera: At Baiia, 4 cases and 3 deaths; at Resina, 3 cases and 2 deaths. Between the 24th and 29th instants no cases have been reported in the consular district.

#### CASTELLAMARE, 1886.

From the commercial agency at Castellamare, Italy, October 8, 1886, is the following:

I herewith submit the number of cases and deaths by cholera which have occurred within my agency during the past quarter. Torre Annunziata, a sea-coast town of some 15,000 inhabitants, and 5 miles due north from here (Castellamare), has had by official returns 307 cases and 135 deaths. Torre Annunziata, like most Italian towns, is very dirty, and as cholera feeds upon filth and dirt, the disease was confined to the filthy localities, and to the lower classes. Castellamare, with a population of 30,000, had only 21 (reported) cases, and 17 deaths, all of the former class. The great difference of the scourge in the two localities is due wholly to cleanliness and good water. The dreaded disease seems to be at an end. No cases here since the 23d of September, while at Torre Annunziata only 1 case was reported yesterday. The first case of cholera reported within my agency was August 15, 1886.

#### FLORENCE AND CAGLIARI, 1886.

A dispatch from the consulate of Florence, Italy, of June 5, 1886, advises the Department that on the 3d instant two persons, residents of Florence, were taken ill and died in a few hours; and to-day I am informed that the disease was cholera. Every precaution has been taken by the authorities to prevent the spread of the disease.

In a dispatch from the same consulate of June 25, 1886, the consul reports: This morning the lazaretto, or hospital for those persons who had been in contact with patients suffering from or suspected of cholera, was closed. The authorities consider that all trace of the disease (cholera) has disappeared. The general health of the city and district is reported good.

In a dispatch from the same consulate, September 25, 1886, it is announced that 7 cases of cholera had suddenly appeared at Cagliari, which port has hitherto been free from the disease.

In a dispatch from the same consulate, of October 23, 1886, a copy of a letter received from the consular agent at Cagliari, Sardinia, is forwarded. In this the consular agent declares that the disease has decreased, but not as yet disappeared.

In a dispatch dated October 29, from the same consulate, the consul quotes the commercial agent at Cagliari as saying, on the 25th, that since the 20th no cases of cholera have been reported here or anywhere else in the island.

#### CHOLERA IN VARIOUS PARTS OF ITALY, 1886.\*

In a dispatch from Rome, May 6, 1886, the consul-general states: I have the honor to inform the Department that the existence of cholera at Venice has been at last officially

\* Reports of the U. S. Consul-General at Rome, 1886.



reported by the authorities, and a lazaretto for the reception of cholera patients has been opened. The disease can hardly be called epidemic, and I do not think there is much danger that it will become so. From the best information that I can obtain, there have latterly been from 3 to 6 cases of cholera daily in Venice. So far, the only official statement as to the disease in Venice is that on May 5, 1886, there were 10 cases, but the number of deaths has not yet been published.

The cholera at Brindisi is decreasing, and apparently about to disappear. No fresh cases and but 1 death occurred at Brindisi yesterday (May 5). In the neighboring communes there were on the same day, in all, 5 cases and 1 death.

In a dispatch from Rome, May 11, 1886, the consul-general writes :

I have the honor to report that the cholera has made its appearance at Bari, where there were yesterday 20 cases and 10 deaths. A few cases are alleged to have occurred at Bari prior to yesterday, but no official information as to them can be obtained.

In Venice there were yesterday 13 cases of cholera and 8 deaths, of which deaths 6 were of preceding cases. The disease has neither increased nor diminished in Venice since the date of my dispatch of May 6.

At Brindisi no cases and no deaths occurred yesterday from cholera. Danger at that place is now apparently over. The disease still lingers in the neighboring communes, though it seems to be dying out.

Except the places above mentioned, there is no cholera in Italy.

In a dispatch from Rome, July 30, 1886, the consul-general writes as follows :

As exaggerated reports as to the extent of the cholera in Brindisi appear to have reached the American press, I have the honor to submit the following facts, obtained by me from the sanitary authorities here as to the cholera in Brindisi and elsewhere in Italy.

The greatest number of cases and deaths from cholera in the town of Brindisi occurred on June 29, 1886, when there were 24 cases and 6 deaths.

In the vicinity the disease has afflicted fifteen or sixteen communes, the most important of which are Latiano and Francavilla. It reached its worst at these places on July 4, when there were 113 cases and 28 deaths at Latiano; 101 cases and 31 deaths at Francavilla.

Both at Brindisi and its vicinity the disease is now decreasing. On July 27, the date of the latest return, no deaths and no new cases occurred at Brindisi; 3 deaths and no new cases were reported at Latiano, and at Francavilla there were 7 cases and 3 deaths.

The cholera is prevailing also at Manduria, a town of about 10,000 inhabitants, in the province of Allece. There were 13 cases and 3 deaths at this place on July 28, where it is thought that the epidemic has now reached its height.

The cholera had appeared at Ferrara on June 14, 1886. The greatest number of cases and deaths at Ferrara has not exceeded 3 in any one day. Several communes in the vicinity of Ferrara have suffered severely, especially those of Massafiscaglia and Cadigiro. At the former place the maximum of cases and deaths was reached on July 17, when there were 25 cases and 5 deaths. In Cadigiro the maximum was reached on July 11, when there were 12 cases and 5 deaths.

On the 22d of June, 1886, the cholera appeared in Bologna, where there occurred, on July 12, 6 deaths and 12 new cases, which was the greatest number reported in any one day.

The cholera has virtually disappeared from the city of Venice, though an occasional case is still reported. In the provinces of Venetia, Udine, Padua, Vicenza, and Treviso, many cases are reported, most of which occur in the small towns. On July 28 there were in the province of Venetia 39 cases and 6 deaths; in that of Udine, 14 cases and 4 deaths; in that of Padua, 78 new cases and 27 deaths; in that of Vicenza, 55 cases and 25 deaths; and in that of Treviso, 96 cases and 37 deaths. It may be noted that with the exception of Bologna, Venice, and Ferrara, the large cities of Italy are entirely free from cholera. The chief health officer in this city informs me that the average mortality from cholera in the various Italian towns where it has appeared varies little from 50 per cent. of the persons attacked. In those places, however, where the epidemic has spent its force and is diminishing, the percentage of mortality is much less. No cholera bulletin is published by the Italian Government this year.

In a dispatch from Rome, October 10, 1886, the consul-general reports that on Friday last a workman in the city died with every apparent symptom of Asiatic cholera. The house of the deceased was at once disinfected and the inmates isolated. As yet the authorities class the case as "suspected cholera," but the delay of the physicians in making public their report leaves no doubt in my mind that the case is one of genuine Asiatic cholera, and I do not feel justified in waiting any longer for an official admission of the fact.

Three other alleged cases, 2 of which were followed by death, are reported by the press, but it is possible that these were not Asiatic cholera. This is the season when the new wine is brought to the city, and although its sale is illegal, many people drink it at the risk of severe cholera morbus.

The health of the city is excellent, and I have little or no fear of a cholera epidemic. The water supply can hardly be contaminated, and the authorities are intelligent and energetic in enforcing sanitary measures.

In a dispatch from Rome of October 13, 1886, the consul-general reports: I have the honor to inform the Department that there have been up to the present date 5 cases of Asiatic cholera in this city, of which 3 were fatal. There have also been 5 "suspected cases," none of which proved fatal. These all occurred among the laboring classes, who at this season are addicted to eating green fruit and drinking new wine. The first persons attacked by the disease had recently arrived in Rome from a place where the cholera has recently prevailed.

About fifty persons who had been in contact with cholera patients here have been isolated by the authorities, and the sale of figs, water-melons, and certain other fruits has been forbidden.

In a dispatch from Rome of October 22, 1886, the consul-general reports the disappearance of cholera from that city.

#### APPEARANCE OF CHOLERA IN CATANIA, 1887.

The U. S. Consul at Catania reports as follows, February 28, 1887:

I have to report the breaking out of the cholera in this city. Last evening rumors were afloat in the city that cholera was prevailing. This morning I called on the prefect of the province for official information. He said that the physicians had decided that the malady is cholera; that he had a few minutes previous telegraphed his Government at Rome to that effect. He stated that the disease first appeared on the 21st of this month; that the physicians were slow in making up their minds as to its nature. He said there had been already 15 cases and 9 deaths; that the cases were scattered throughout the city, not being confined to any particular locality; that there was not more than 1 case in a house with one exception in which there were 2; that the physicians reported the disease to be without epidemic features. There are 2 new cases to-day which are included in the number above stated.

The prefect said that he had already ordered that sanitary measures be at once taken, and that all would be done that possibly could to stay the disease.

The city is in a bad condition to withstand such a scourge. Many of the streets are without drainage. The side streets and alleys are exceedingly filthy. The poorer classes are crowded together in dirty, poorly ventilated, comfortless rooms.

As the heat of summer sets in (unless the dire malady should be stayed), the sacrifice to death will be fearful.

The people are greatly alarmed. Many of them are flying to the slopes of *Ætna*.

#### THE CHOLERA IN MESSINA, 1887.

The United States consul, in his dispatch dated October 12, 1887, says:

Messina numbers within its old walls 70,000 inhabitants. The narrow streets of one-fourth of the city proper, the most densely populated section, are unpaved. The suburbs, with a population of 50,000 inhabitants, are also unpaved. As there is a sad lack of privies throughout the city, slops are thrown into many of the streets. The sewers, insufficient in number, empty on a narrow strip of beach that runs along the quay; this beach is exposed to



the sun except at high tide. The tide in the straits of Messina is about 10 inches. There are no means of flushing these sewers; the winter rains alone cleanse them. During the summer, the dry season, the sewer-gratings are tightly plugged up, as the stench from them is very great. The drinking water is drawn from wells and public fountains fed by mountain streams, which are generally tapped too near the town; frequently the water, before it has entered the porous earthen pipes, has been used by the country people for washing purposes. As stated in my dispatch No. 39, dated September 13, but 2 cases of cholera occurring from August 27 to September 8, confidence was restored, and refugees returned to the city in great numbers for the municipal election of September 8. On September 10 the epidemic broke out most suddenly, and in an aggravated form. For ten days the disease ran its course unchecked. The greatest number of deaths (there is no record of the number of cases) were reported September 14, 256 in twenty-four hours. On the 20th arrived Professor Canalis, sent by the minister of the interior. He at once took charge of the sanitary bureau, disinfected certain portions of the city, established steam-engines to supply the citizens with boiled water, ordered pure drinking water to be sent from the continent, and closed the wells and fountains. As soon as these sanitary measures were carried out the epidemic abated, and atmospheric changes ceased to influence the disease. The cessation of the scourge is due to Professor Canalis's energy. Well-boats will continue to supply the city with drinking water until pure water from the mountains can be introduced; pipes are now being laid for that purpose. The recent epidemic resembles in character the Tonquin cholera, introduced into Europe a few years ago by the French. It has become, however, somewhat modified, the first two stages running rapidly into the third, the three stages not being well defined, as in Asia. The remedies used in the first stage were laudanum and chlorodyne, and hypodermic injections of morphine, the limbs being rubbed with spirits of camphor or brandy. In the cold stage hypodermic injections of a solution of citrate of ammoniated iron have proved of great value. \* \* \* Between September 10 and 25, 34 per cent. of persons attacked died. A visit to the cholera burying-ground three days ago showed the mortality to have been greater than reported, 2,100 corpses having been interred there since the outbreak. During the epidemic soup-kitchens were opened for the indigent. \* \* \* The cholera was particularly fatal to the old, the weak, and the very young, and was confined, with but few exceptions, to the poor. The epidemic is now virtually over; but 4 cases and 1 death have been reported for the last twenty-four hours. The streets are still deserted, and commerce and trade are at a stand-still. Quarantine has not been enforced in the Sicilian ports this past season.

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#### HYGIENIC CONDITION OF NAPLES.

While discussing the hygienic conditions of the people of Italy, it may not be out of place to say a few words concerning the city of Naples, as they will explain to some extent, not only the fearful havoc caused by cholera during its visitations of this city in the past, but also throw some light upon the great prevalence of typhoid fever in that city, which is such a favorite resort during the winter for invalids and pleasure seekers from all parts of the world. I shall limit these remarks to the water supply and disposal of sewage. The site of this city is perhaps the most beautiful in the world. The town is built partly on an alluvial plain, the surface of which in many places is only a few feet above the level of the water of the Bay of Naples, and partly upon the hillside. The section of the city, perhaps the most popular among the visitors, the Chiaja, is built upon ground reclaimed from the bay and is the newest and most handsome quarter. In it are a large number of the finest hotels most frequented by travelers, and through it two of the largest sewers of the city run and empty directly into the bay. Besides these large sewers there are numerous other smaller ones which also empty their contents into the waters of the bay in this quarter. The largest and most popular hotel of this quarter is built directly over one of the main sewers. This hotel is seldom or never free from cases of typhoid fever. The drainage of the hotel is extremely imperfect. Although the water-closets are trapped, it is but very imperfectly, and there is no competent provision for flushing the drains.

During the night, and also during the day, when the wind is blowing from the south or south-west, the corridors and the rooms of the hotel are filled with sewer gas, oftentimes to such an extent as to make it a relief for the inmates to get out into the open air. Besides this, the ground upon which the hotel is built is porous, and the main sewer is so imperfectly constructed that its fluid contents have no difficulty in filtering outwards into the surrounding earth.

The most frequented drive in the city of Naples is along the bay edge of the Chiaja, and its western extremity alone separates this hotel from the bay. At this point the stench from the decomposing matter dumped into the water by the main sewers is often insufferable. So that, in addition to the gases which permeate every part of the hotel directly from the water-closets and which emanate from the porous soil beneath, there is a re-enforcement by the mephitic air swept by the winds against the side of the hotel from the mouths of the sewers, and the filthy water of the bay. The most extensive system of sewers is in that portion of the old city east of the via Roma. Many of the sewers of this portion of the city are upwards of two hundred years old, and the imperfections of their early construction have been increasing for two centuries. They are frequently irregular in their level, commonly imperfectly cemented, and of a very faulty transverse section. The main sewers are often without any other floor than that formed by the primeval earth. Leakage of the fluids into the surrounding soil is constant, and the formation of pools and obstructions in their course is unavoidable. Besides this, in the low, flat portions of the city their declivity is quite inadequate to provide for an efficient discharge. Furthermore, provision for their ventilation is either entirely absent or extremely imperfect. It can be readily seen from what has been said that any thorough flushing is an absolute impossibility. The house connections with the street sewers are also very imperfect, and the absence of traps is the rule rather than the exception. In Naples also, as in other towns of Italy, the practice of throwing night-soil and household refuse from the windows is quite prevalent in many parts of the city.

The houses of the poor quarters are many stories in height and are tenanted by families who live in flats. The upper flats are constructed upon the same plan as the lower ones, the kitchens of all being directly over each other. The water-closets, when they exist, usually occupy one corner of the kitchen and connect by untrapped pipes with the main perpendicular drain which leads to a *pozzo nero* in the basement of the house. It is usually only the overflow of the fluid contents of the *pozzo nero* which enters the main house drain and passes to the street sewer. The walls of these *pozzi neri* are usually very imperfectly or not at all cemented, the floor of the sink being formed by the porous earth. The solid accumulations in the *pozzi neri* are not often removed more than once a year.

The following peculiarities in the water supply of Naples may be mentioned. In most of the large houses there is an individual provision for water in the following manner: Running water flows in masonry trenches from house to house, ordinarily a little under ground. In the course of the trench as it passes beneath the house there is a cistern sunk beneath the bottom of the trench in order to form a species of water reservoir for household purposes. This reservoir is usually located in the part of the building immediately under the kitchens of the various floors, and is in communication with them by means of a bucket attached to a rope which runs over a pulley at the top of the house, so that the occupants of the various stories can draw the water without the necessity of descending to the ground floor. The location of these reservoirs is, therefore, frequently in close proximity to that of the *pozzi neri*, and from what has already been said of the construction of these *pozzi neri*, it is easily understood how filtrations from the latter must unavoidably reach and contaminate the water of these reservoirs. And the fact that the water trench passes from house to house and directly communicates with the reservoirs, explains how in houses where the *pozzo nero* and the reservoir are quite distant the water drawn from the reservoir is often necessarily contaminated by the *pozzi neri* in houses up-stream.

Besides this household provision of water, there is also a public supply by means of a comparatively limited number of public fountains in the streets and public squares. The majority of the inhabitants recognize the fact that the water of the public fountains is of a better quality



for drinking purposes than that drawn from the reservoirs within the houses, and those living on the ground floors, and not too far distant from the nearest public fountain, habitually resort to the fountain for their drinking water, using, however, the reservoir water for other domestic purposes.

It was a curious fact that during the prevalence of cholera in Naples in 1884, and indeed in nearly all of the preceding epidemics, contrary to the customary rule in cholera epidemics in most parts of the world, those dwelling in the upper stories suffered most severely from cholera. The explanation of this fact is patent. The ease with which the dwellers in the upper stories could obtain water from the reservoir, and the inconvenience of resorting to public fountains, caused them to use water which was by far most likely to be contaminated by cholera discharges. In addition to the contamination of the reservoir water by cholera discharges which might reach the "*pozzo nero*," in not a few instances the reservoir water was further contaminated by the reckless practice of washing linen soiled with choleraic discharges in the trenches of running water beneath the houses.

The city of Naples has had an instructive experience with regard to pure water which may be looked upon as a complement to that already related of the city of Genoa. It has been seen how severely Naples suffered from cholera in 1884, and how liable the common household water supply was to become contaminated with excrementitious matter. During the following year pure water was brought into this city from a mountain stream (the Serino) eighty miles distant, and very generally distributed through iron pipes, under pressure. At the same time the old system of distribution by water trenches coursing beneath the dwellings was to a great extent done away with. Neither in 1885 nor in 1886, notwithstanding the existence of cholera in her vicinity and the not infrequent arrival of refugees from cholera-stricken localities, did this city suffer from even limited epidemic outbreaks of the disease. This was true also of the year 1887, until, in consequence of a break in the new water conduit from the distant mountain stream, recourse for a few days was had very generally to the old water system. At this time there were numerous refugees in the city, as in fact there had been for weeks, from various places in southern Italy and Sicily, including several suburban towns, where cholera was more or less prevalent. And there were, and had been almost constantly occurring, a few isolated cases of the disease among these refugees, without, however, a localized epidemic being produced thereby. But very soon after the interruption of the supply of pure Serino water there were one or two quite sharp explosions of local epidemics around some of these cases, grave enough to cause very considerable anxiety lest the unfortunate experience of 1884 was to be repeated. The speedy repair of the Serino aqueduct enabled the municipal authorities again to turn on that pure water throughout the city; and practically coincident therewith these local epidemics, which had occasioned so much alarm, ceased almost as suddenly as they began. It may not be uninteresting to incidentally remark that the municipality of Naples has profited in other respects also through the benefit of improved water supply. The statistics of Neapolitan hospitals for infectious diseases for three years previous to the introduction of the new water supply, and for three years subsequent thereto, strikingly illustrate the economic advantage of pure water:

*Number of cases before and after introduction of pure water.*

Diseases.	Before.	After.
Typhoid .....	333	76
Typhus .....	317	77
Low fevers .....	82	26
Intermittent fevers .....	93	62

While mentioning the improvements in the public water supply which have taken place in Naples since the great cholera epidemic in that city of 1884, it seems proper to refer also to other comprehensive hygienic improvements projected as a result of the sad experience of 1884. Broad avenues, lined on either side with spacious and well-constructed buildings, are

to be cut through the densest and most noisome quarters of the old city, which have always been most ravaged by epidemics, and a greatly improved general system of sewerage is to be executed. These projected improvements are estimated to cost upwards of \$60,000,000 and to require ten years for their completion, and, it is believed, will go far towards the destruction of this plague-spot of southern Italy.

The geological formation of the ground upon which Naples is built is of volcanic origin. The rocky bed of the hillside consists in the main of *tufa*, a moderately hard, but extremely porous lava. Most of the buildings of Naples are constructed of this material, and it enters also into most of the masonry work throughout the city, including the walls of wells and sinks as well as public sewers. Thus, when it is understood that cement is wanting, as a rule, the percolation through solid walls of moisture and fluids holding in solution organic material is easily explainable.

While discussing the hygienic conditions and mode of life which prevail in Italy, reference may be made to the great number of fêtes and holidays during the course of the year, as they have a marked influence often upon the course of cholera epidemics in that country. During these times it is the custom among the inhabitants of the cities and villages, especially of the poorer classes, to move into the country in large crowds for the purpose of recreation and pleasure. On these occasions the use of overripe and unripe fruits and the consumption of poor wines, and at certain seasons of the year, also, of large quantities of the new wines is the rule, intemperance of all kinds being extravagantly indulged in. Even the prevalence of epidemics does not stop these indulgences, and the days following the fêtes are universally marked by the increase of all sorts of digestive disturbances.

Another circumstance may be mentioned which will also throw some light upon the spread of epidemic diseases, especially those which may be caused by the introduction of the infectious principle by way of the digestive apparatus. I refer to the constant practice of the washing of clothing in running streams, which frequently supply the inhabitants with drinking water. The danger from this source is also greatly increased, especially in certain parts of Northern Italy where artificial irrigation for agricultural purposes is extensively practiced. The irrigation canals are generally also used as public lavatories and reservoirs of drinking water. They occasionally also serve, especially in their passage through small villages, as public sewers. It is not often that when the public sewage is turned into the irrigation canal from a given village that the inhabitants of that place use these canals also for the supply of drinking water; but the inhabitants of the village below, if they do not empty their sewage into the stream, usually make use for all domestic purposes of the same water contaminated by the sewage of the village above. The course of these canals is frequently by the roadside, and the level of the road is such that the fall of rain-water sweeps the movable filth directly into the canal. The superabundance of water during wet weather also frequently finds its way from the surface of the fields into these canals, carrying with it, to a certain extent, the soluble parts of the manure used to enrich the soil.

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#### HYGIENIC CONDITIONS AND MODE OF LIFE IN PALERMO.

Much of what is said here will apply in a general way to the whole of Italy, Southern France, and Spain. The city of Palermo rests upon an alluvial soil. The débris of the surrounding mountains has been washed down from them by the rains and by the mountain streams for thousands of years, forming a flat plain of some few miles in breadth, bounded on the east by the Bay of Palermo, and on the north, west, and south by mountains and hills arranged in the shape of a semicircle. Surrounding the city of Palermo, which has about 275,000 inhabitants, are very fertile gardens and orange groves abundantly watered by small streams and irrigation canals. The city receives its water supply from several sources. The water comes to the city from the surrounding hills and mountain peaks, usually in open trenches of masonry, and, after reaching the borders of the city, passes within it and is distributed usually through the same sort of water-ways, now, however, customarily covered. For the pro-



vision of the more elevated portions of the city there are a few water-towers, into which the water is raised by pumps, for the purpose of supplying water to the upper stories of the houses of the more wealthy classes. These water trenches within the city limits are sometimes, however, uncovered; or they pass beneath the houses, in the basements of which there are traps in the top of the water trenches for the purpose of permitting the occupants to draw the water directly from the courses. A number of public fountains throughout the city are supplied by this running water, and the poor classes, as a rule, supply themselves with water for all purposes by resort to the public fountains. There are, however, scattered through the city, particularly in the poorer quarters, a large number of wells. The well is usually located in a narrow court around which the hovels of the poor are built. These wells are usually deep, and customarily walled very imperfectly. Around the top of the well there is generally a curb, a foot or two in height, formed of loose stones placed together without cement. Around the curb is generally to be found a number of stone washing-tubs, for the purpose of washing soiled clothing. It often happens that the drains from the houses collect together near the center of the court, and therefore in close proximity to the well, in order to form a common larger drain which leads to the sewer in the street. It is an exception that these house and court drains are in a fair state of preservation. They are most frequently clogged or in other ways obstructed; in fact, they are usually constructed of loose stones, uncemented, and it sometimes happens that the slant of the court is towards the well. It is easily seen how with the rain-water and the escape of water from the washing-tubs the water in the well may become contaminated, not only by the water from the washing-tubs, but also by the surface rain-water of the court, and even also the filthy water which runs in the neighboring drains. In fact, upon examination of numbers of these wells it was not at all an infrequent sight to observe the drippings at various depths finding their way down the wall of the well.

The public water already alluded to is distributed throughout the town sometimes in terra-cotta closed pipes and water mains running beneath the surface of the street near the curb on each side, and sometimes in square trenches of stone or brick masonry often very imperfectly cemented.

The system of sewerage in Palermo is, as in most Italian towns, very imperfect. The streets, as a rule, are well paved, with the surface slightly raised in the center of the street. A large collecting sewer usually runs a few feet beneath the surface under the middle of the large streets. Its construction is very imperfect, both as to the tightness of the walls and as to the level of the floor of the sewer. Side connections are made from time to time with adjoining houses to receive the overflow from the sink, or *pozzo nero*, when it exists in the basement of the house. These sewers unite as they pass toward the harbor into one or two large main sewers which converge from various directions to empty into that portion of the port known as La Cala. The surface water, which includes the rain-fall upon the streets, the water for cleansing the surface of the streets, and often the water used in the houses for domestic purposes, such as washing and cleansing the house, is collected by the gutters on either side of the street and conducted by them according to the natural declivities to the port. From the imperfect construction of the walls of the sewers, as also of those of the water trenches and water mains of terra-cotta, it is not a difficult matter to have frequent contaminations of the public water supply of the town during the course of distribution throughout the city.

Furthermore, from the existence of traps in the tops of the water trenches, as already described, it is easy to see how a more direct contamination of the public drinking water may take place by the carelessness or the intention of the inhabitants of houses wherein these traps exist. A further source of contamination of the public water within the town is to be found in the habit in some localities of washing clothing near the border of the basins receiving the water from the public fountains. In addition to these possibilities of contamination of the public water within the city, the conditions under which the water is brought to the city also explain how difficult it is for the water, although pure at its source, to reach the borders of the city without contamination.

I have spoken of the conveyance of the public water to the city in open trenches of masonry. In the neighboring suburbs, and especially in the small villages along the

course of these water trenches, it is a common thing to see provision for the washing of clothing and the drawing of water directly from the running stream at various places along the trenches. This provision is in the shape of stone steps leading up to the top of the wall of the trench, ending in a stone platform of some breadth only a foot or two below the level of the top of the wall. Sometimes stone wash-basins rest upon this platform, and, besides, the inhabitants resorting to the trench for their water frequently bring their own portable wash-tubs to the same place. It is a daily occurrence to witness the washing of soiled clothing at these places, and during the process of washing to see the frequent dipping of the water from the trenches with vessels none too clean. In fact it is a known circumstance that the filthy habits of the peasantry, and their utter disregard of the rights or welfare of their neighbors, cause them not infrequently to complete the process of cleansing the clothes by giving them a final rinsing in the running stream itself. Besides this very common way of contamination of the water in its course toward the city, there is still another which is almost in constant action. The suburban gardens and orange groves, as I have said, are abundantly watered both by running streams and irrigation canals; they are also richly manured by the use of human excreta obtained from the city. The water trenches in various parts of their course are oftentimes below the level of the ground they traverse, and in examining some of them I found places along their course where the top of the wall of the open trench was not only below the level of the surrounding orchards, but, worse still, the slant of the ground was toward the trench. During the time of heavy rain-fall it is easy to see that some of the surface water from this ground, which is the recipient of the manure of various sorts from the city, can find its way into the water trenches and thus reach the inhabitants of the city. Furthermore, besides these many faults in the public water supply of the city of Palermo, during the season of drought, especially in the summer, the inhabitants not infrequently suffer from scarcity of water, a fact which, perhaps, lessens to a considerable degree what little daintiness remains among the inhabitants and public authorities with respect to the purity of the public water.

The city of Palermo presents to the eye of the visitor who simply promenades the principal streets or drives around the city the appearance of being one of the cleanest cities in the world. As I have said before, the streets are in the main well paved. The surface of the streets, especially in the principal thoroughfares, is kept reasonably clean by sweeping and by watering. The houses are of an attractive style of architecture and are usually built of a light-colored stone, or are covered with a light stucco, and the general impression which strikes the traveler is that the city is unusually clean. But the moment one steps aside from the public thoroughfares and enters the adjacent alleys and courts, even though within a few steps of the most frequented street of the town, he will find them reeking with filth and every abomination.

The dwellings of the poor, and there are large numbers of this class in the city of Palermo, are usually solidly constructed, having very thick walls, and are several stories in height as a rule, surrounding an open court in the interior. The only entrance to these dwellings is often through a dark, narrow, filthy passage-way leading from a noisome alley into the interior court. It is not unusual for a hundred or more people to crowd together into the building surrounding the court. In these miserable habitations of the poor, the lower story is frequently without pavement of any kind, the bare ground constituting the floor. Besides, the level of this floor is often below that of the court. It is the rarest thing to find a kitchen or any provision for fire within the interior of these dwellings, the climate of Palermo being so mild that even in the winter fire is not an absolute necessity for warming purposes, and the inhabitants universally have a deep-rooted prejudice concerning the unhealthiness of artificial heat for such purposes. When the kitchen exists at all as an attachment to these houses, it is in the shape of a small stone balcony projecting from the exterior wall, of perhaps a cubic meter in area. In these dwellings the disposal made of the household drainage and night-soil accumulations is customarily out of the window into the court, or into the recesses of the dark stairway leading to the ground floor, or, when the inhabitants are more fastidious, into the mouth of a drain leading to the court, which is located just inside the door-way,



in the floor of the hall, and is very imperfectly covered by a stone or metallic lid, leaving cracks through which the mephitic gases from the drain find a ready communication with the air of the hall-way which connects with every room in the house. The rooms are small, and in the winter cold and damp. It is the rule that a family of several members occupies a single room; in fact I have frequently seen a dozen people crowded into one of these apartments not over 15 feet square, and with them also a considerable number of domestic animals. As a matter of fact, on the ground floor it is usual for goats and asses to be tenants in common with the human animals, and in these cases, especially where the human tenants are interested in the practice of agriculture in the suburban orchards, it is very common to see the ground covered inches deep with the accumulated excrement and dirt of these beasts; the night-soil in this case, instead of going through the windows into the court, being thus stored for the production of manure.

In the dwellings of the middle classes there is considerable improvement upon these miserable hygienic conditions. The dwellings are still built around an open court, but they are much more commodious. What has been said respecting the absence of any provision for artificial heat and kitchens within the apartments of the dwellings of the poor applies equally well to the habitations of the middle classes, and the practice of dumping the household filth through the window into the court, or in the mouth of the house drain at the entrance of the hall, is common with these classes also; but oftentimes there is found a water-closet of rude construction which connects, without any intermediation of traps of any kind, or provision of adequate flushing, with the mouth of the drain at the entrance of the hall on the ground floor. Sometimes the pipes from the water-closet lead directly into a *pozzo nero* of some size beneath the floor of the entrance hall, and in this case the accumulations in the *pozzo nero* are usually removed only once a year during the season when the material is most required for agricultural purposes. The walls of these *pozzi neri* are uncemented and their floors are formed simply by the porous soil. Occasionally in the courts of these dwellings the water-well, when it exists, instead of being located in the middle of the court, is placed in one corner against the wall of the dwellings, and an arrangement consisting of a pulley at the top of the house and a long rope running over it attached to a bucket is made for the drawing of water by the inhabitants of the several floors. It is understood that the *pozzo nero* is then frequently in very close proximity to the water-well, and that it is a common thing for the filterings of this sink to reach and contaminate the water in the well. In this case all the water for every domestic use, including the cleansing of dishes and the preparation of food, is contaminated by those excrementitious substances which are soluble.

The dwellings of the upper classes are of course usually well located upon the broad, handsome streets, and are handsomely constructed and very spacious; but the habit of building around an interior court still prevails among them. These residences are commonly supplied with public water, and there often exists a fountain within the court which serves not only for ornamentation but also for domestic purposes. The water-closets in these houses are conveniently arranged, as a rule, but there is no such thing as a siphon or trap in the drains which lead from them, except in the dwellings of rich English or American foreigners, of whom there are naturally a large number in Palermo during the winter. In the palaces of the rich natives, however, there is the same absence of arrangements for furnishing artificial heat which has been noted already in the dwellings of the lower classes. In public restaurants and in the hotels and inns frequented by the natives there is the crudest arrangement of the water-closets. During the time of my presence in Palermo the city was almost deserted by visitors, and the principal hotels for their accommodation were closed. The one large hotel, the Trinacria, which had remained open during the course of the epidemic, only accommodated six or eight guests. This, being located upon a site overlooking the beautiful bay, is always one of the most popular resorts for transient visitors, and is furnished with all the modern accommodations required by English and American travelers, such as convenient lavatories and well-arranged water-closets. But it was the custom among the guests of this hotel during my stay there, as with most of the gentlemen of the upper classes in Palermo, to take their mid-day breakfast in the most popular restaurant of the city, located upon the principal thoroughfare,

the Corso Vittorio Emanuele. The water-closet of this fashionable restaurant is located in the kitchen, and is of the crudest description. Between two tables upon which the food is prepared, against one of the walls of the room, the open pan of the water-closet is situated, without a trap or even a cover. This location of the water-closets in the public inns and cafés is almost universal throughout Sicily as also a greater part of Italy.

The supply of food is commonly abundant and of a fair quality, consisting largely of various fruits, and grapes in their season, with melons, figs, oranges, and prickly pears. The supply of vegetables is usually almost unlimited, as also is that of fish, including a few oysters of an inferior quality.

The staple food of the Italians of the lower classes consists mainly of macaroni prepared in various styles, but usually cooked with tomatoes and cheese. The universal drink is a light, sour wine, usually diluted with water. During the time of the epidemic there was close municipal inspection of the quality of the food supply introduced into the city, especial care being taken to condemn and dump into the harbor unripe and overripe fruit, as well as partly decayed vegetables. The meat of all kinds was also rigidly inspected.

During my sojourn in Sicily I had occasion to visit some of the neighboring villages in the vicinity of Palermo. What has been said of the construction of the dwellings of the lower classes will apply very fairly to almost every habitation in these little towns, the chief difference being that the crowding together of men and beasts in the lower stories was often more accentuated, and the filth in the courts and in the public streets was far more abundant, there being usually no provision whatever for its removal from the public streets except by the downfall of rain; and the accumulations of human excrement dumped in front of the houses, from the windows and doors, everywhere constantly offend the eye and the nose.

The population is most ignorant, prejudiced, and lawless. Brigandism existed to such an extent only a few years ago that it was not an uncommon thing for rich and influential citizens of Palermo to be kidnapped within a few miles of the city and held among the mountains for enormous ransoms, which were nearly always paid before the prisoner gained his freedom. Even the prefect of the province, while escorted by his personal guard, was stopped in the mountains and made prisoner, being allowed to escape only after having paid the ransom of 60,000 lire (francs). On the advent of cholera the population became very turbulent, in some places even rising in open revolt. The impression among them was almost universal that the disease was produced intentionally by the physicians and health authorities as emissaries of the Government, who, thinking that the population was too rapidly increasing, had determined to kill off the surplus by poisoning the water and food. This state of affairs at the outbreak of the epidemic paralyzed the efforts of the local government to limit and stamp it out. This popular prejudice was so great that even the most strenuous efforts of those in whom they had naturally the greatest confidence were unable to overcome it. One of the public measures adopted by the municipality of the city of Palermo was a provision for the gratuitous distribution of medicine and soup from public soup-kitchens, extemporized for the purpose. The leading citizens and the local clergy formed local committees for the distribution of medicine and soup among the poor of their districts, but owing to the prevailing popular prejudice, this work of charity was often attended with great personal danger; even the priests were hooted and insulted, with the bishop of the diocese at their head. It was found impossible to induce the people to make use of medicines distributed without some person of the local committee acting the part of taster before their eyes, and even then, when the course of the disease was rapid and fatal, the symptoms were frequently attributed to the medicine administered, rather than to the disease.

The efforts of the authorities to remove the accumulations of filth within the courts and dwellings were often resented, as unwarrantable interferences with individual liberty and property, by riotous demonstrations which the military were obliged to quell at the point of the bayonet. As an instance of such turbulence, which I personally witnessed, even in the last days of the epidemic, I may mention my visit of inspection to a small mountain village in a neighboring province, the village of Belmonte. When the prefect of Palermo learned of my intention to go to this village, where an epidemic of cholera was then raging, knowing the



character of the lawless inhabitants, he insisted upon placing at my disposal a considerable escort of his personal guard. Upon arriving at this village and presenting myself before the official residence of the mayor of the town, I found the main door and the windows of the house completely charred. This was a result of an endeavor by the populace to burn the house the night before, because of the earnest efforts which that official had made to improve the hygienic condition of the town.

Perhaps some description of the hygienic condition in which I found this place may be of interest, as it is a fair representative of the condition of nearly every village, not only in Sicily, but also throughout Italy. This village has a population of about 3,000 souls, and is beautifully located upon the side of a mountain. As is common in Italy, the only building of any pretentious size and appearance is the parish church. The dwellings of the inhabitants were usually of two stories and were built along narrow and tortuous streets. The lower stories were occupied in common by the members of the family and the domestic animals, the floor being covered several inches deep with straw and excrement. The practice existed here, as everywhere else, of throwing the household refuse into the streets, and at the time of my visit, although there had been some previous rains, it was difficult to find stepping places among the revolting filth of all sorts which covered the stony pavement. There was no such thing in the town as an under-ground sewer. The water used by the inhabitants was of two sorts. There were no private wells in the houses. There were two large public wells in the edge of the village, one of which had been closed by orders of the board of health because it had been contaminated by the washing of cholera clothing around the curb. The closing of this well, and the forcible prevention of the washing of clothing around the other well, still remaining open, were the main causes of the efforts of the inhabitants to burn the residence of the mayor, already mentioned. The only other water supply was from a large cistern which collected the rain-water from the roof of the parochial church. The well-water, however, was preferred by the inhabitants.

I may introduce here, and make a part of this report, a recent publication by Prof. E. Albanesi, president of the sanitary council of Palermo, which, besides the discussion of other matters relating to cholera in Italy, very graphically describes the conditions and mode of life common among the inhabitants of that country.

#### CHOLERA, AND THE DUTIES OF GOVERNMENTS AND COUNTRIES DURING EPIDEMICS.\*

Typhoid and scarlet fevers, diphtheria, small-pox, cholera, etc., seem now to have fixed their abode in Italy. The country remains unprovided with sanitary laws, and the Government, lacking ætiological and hygienic knowledge, makes provision only when any disease appears, and nearly always, in consonance with the impressions of the moment, issuing confusing or conflicting decrees, and unreasonable instructions, which are nearly always useless. Thus the cholera has its sway, spreading here and there and often making great havoc. Cities are terror-stricken and force the Government to impose quarantines and improvise cordons, and occasionally give way to deplorable excesses, discouragement, etc., often fatal in their consequences. The sanitary authorities of the kingdom, the superior sanitary council, communal and provincial sanitary councils, the minister of the interior, prefects, and mayors frequently provide contradictory measures, issuing regulations of no efficacy in preventing the spread of infectious diseases. It is useless to relate the detrimental effect of this practice. Many of the regulations are carried out by force, but, worst of all, by foolish busy-bodies† or by charlatans, to whom the ministry, through lack of understanding and through dangerous condescensions, intrusts the study and examination of such and such an epidemic, to the discredit of the science of Italy; and the same may be said respecting the

\* The United States consul at Palermo, Dr. Philip Carroll, has transmitted to the State Department the following translation of a pamphlet issued by Prof. E. Albanesi, president of the sanitary council of Palermo. (Published in the New York Medical Journal, January 8, 1887.)

† See L. Brunetti's "Report to the Minister of the Interior" upon the cholera in Sicily during 1885.

inexact reports, written carelessly by a person whose duty it was to ascertain the facts and things, especially when it was a matter of historical and statistical inquiry.\* And so much for cholera.

As to diphtheria, scarlet and typhoid fevers, small-pox, and other infectious and contagious diseases, it is saying a great deal if a few hospitals have established separate infirmaries, and if a few individuals, foreseeing the coming evil, are thinking for themselves and providing as best they can for the disinfection of their houses. The misguided country actually cherishes the hope that the disease which is now prevailing will shortly leave us, or will end by becoming acclimatized, and thus lose its present severity. But one may hope in vain. The cholera will not abate so quickly; many Italian cities will still have to lament their neglect; and most probably diphtheria, typhoid and scarlet fevers, etc., will never leave us if we do not provide against them earnestly and intelligently. It is true that we are accustomed in Italy to the fatal consequences of typhoid and scarlet fevers, and diphtheria, which interruptedly assume an epidemic character. But I fear we can never become accustomed to cholera; the fact is, the results will be always very serious, and it is therefore necessary to provide against them with care. History shows us that whenever cholera has appeared in Europe it has always remained for several years together; in Prussia, an epidemic raged during twelve years, viz, from 1848 to 1860. But once the present epidemic has been stamped out, who will assure us that there will not be shortly another importation thereof from India? Within half a century—*i. e.*, from 1835 to 1884—Italy has been invaded six times by the cholera, and on each occasion it lasted three or four years. Now that commerce has increased, and has rendered communication by the sea easier and shorter, it is to be presumed that visits of a similar nature will be more frequent. One should not therefore cherish vain hopes, nor be satisfied by recurring to more or less uncertain expedients; one must seriously think for the future, and protect public health with good laws and efficient regulations.

Shall we still rely upon quarantines, and upon them alone? Putting aside the necessity of commerce, at the present time, the traveling of people to and fro is so continual, rapid, imperative and important that it is quite impossible to arrest it by means of cordons and lazarettos. It is true that quarantines would be useful on the Isthmus of Suez; this I affirm, and I desire our Government should insist upon such a guaranty. But events have thus far shown that they have been inefficient on the Red Sea, either because the guard was not vigilant enough, or because there was temptation to elude it, which is frequently done by force. The fact is, the whole of Europe, which is interested in the prevention of the introduction of cholera, failed in its attempt to guard Suez. Europe would not be totally secure, even if quarantines were to be maintained at Suez and if the "maritime sanitary council" were to be re-established. We might be secure from the sea, but how could we guard against the approach by land? One must not forget that cholera travels also by land, that it was in this manner that it first reached Europe, and that by following the same route it returned in 1869 and 1870.

We then had occasion to see how the famous cordons worked, and how their trial made in Alexandria in 1883, and on the Italian frontier in 1884, not only proved insufficient, but dangerous on account of the facility of infection thereby, for which reason they became the centers of the disease. It appears to me, without being other than a simple localist, and believing that the doctrine of the contagionists, in its present state, is worthy of the greatest consideration, that to place one's whole trust in quarantine is a mistaken system of defense. If one could have all the money back which has been thrown away on quarantines and cordons, as well as compensation for the losses sustained by commerce in consequence of the damages caused by these measures, there would certainly be sufficient capital at hand for hygienic purification; if, therefore, the money and time which have been wasted had been employed in

\* Professor Pagliani, "Report upon researches as to the manner in which the cholera epidemic was introduced into Palermo, and its spread in the year 1885," addressed to the minister of the interior and published in an appendix to the official report on the cholera in Italy in 1884-'85, by G. B. Morana, M. P., secretary-general of the ministry of the interior.



purifying certain towns, certainly the cholera or any other infectious disease would either have disappeared or would no longer cause the violent destruction of life which we still lament in so many places.

At present there are but few who believe in quarantine, and fewer still who trust in cordons. There has even been a rupture in the "maritime sanitary council" in Egypt,\* and it will be difficult to remedy it, because it is brought about by the economical and military interests of certain nations, and because it is based upon a diversity of opinion existing in high medical spheres, both civil and military, in England, as to the manner in which cholera is developed. And this want of trust will be still more marked and will end by convincing the greater part of the world, which trusts in quarantines, etc., when the new theory of microbes is universally accepted. All hygienists admit that infectious diseases are due to microscopic living beings, which belong to the class of *schizomycetes*, and are named, according to their forms, micrococci, bacilli, bacteria, vibrones, and spirilla. If these infinitely small beings, even in small numbers, penetrate an individual who is predisposed to infection, or if they fall on a fertile field for their cultivation, they rapidly increase and produce an epidemic.

Now, when every one understands and appreciates the gravity of the fact that 30,000,000,000 of these creatures hardly weigh a milligram when dry, then the supporters of quarantines and those who at the first alarm of cholera begin to vociferate as loudly as they can, will, I am certain, recognize the uselessness of quarantines, or at least they will no longer feel secure when a quarantine has been established. There would be no more custom-houses if a decimeter of contraband stuff, after entering a place, were to suddenly become millions of meters, and there would be no more excise duty if a single lamb, after being secretly entered in a town were to suddenly become a numerous flock. For the same reason there will be no more quarantines, or at least their efficacy will be doubted, when it is in the power of every one to comprehend the serious destruction which the thousandth part of a milligram of microscopic beings can cause, and when everybody understands that these invisible beings can be preserved in favoring conditions of life and activity for a very long period, and can penetrate the strongest barrier, whether they be attached to part of a garment, or exist in a rag, or in a little water, or in any object whatever.

With regard to the cholera, because of which Europe continues to talk of quarantines, and with which Italy especially is preoccupied, there are two theories as to the mode of its propagation, viz, the localist and the contagionist theories. The theory of spontaneous development, which was last supported by Guérin, at the Academy of Medicine of Paris in 1884, has been completely annihilated. Localists and contagionists admit the parasitic nature of cholera, and agree in the belief that the evil originates in India, and that it is carried by human beings and commerce; but the two theories differ widely as to the manner in which an epidemic is developed. Von Pettenkofer and Cunningham, who are the exponents of the localist theory, believe that cholera becomes an epidemic according to special circumstances, places, and seasons, and they hold that the infectious agent is derived from places abounding with cholera, and not from the person attacked by cholera, so that the cholera germ (these are von Pettenkofer's words †), "adhering to articles of commerce in an unknown form, to be determined by bacteriologists, develops when it finds a fertile soil, and becomes a new cholera-disseminating focus which gives rise to epidemics, or a sterile soil, when the introduction of the germ has no effect." The contagionists, in whose ranks stand Fauvel, Brouardel, Koch, Proust, and nearly all the great physicians of France and Italy, believe that the cholera, transported by commerce, produces epidemics through the intercourse of human beings and infected objects, and that everything can convey the disease—the atmosphere, the soil, and especially potable and river water. In my belief, contagionists and localists have both erred; the former in having wasted so much time and labor in trying to demonstrate that quarantines and cordons were the

\* See "The Cholera in Egypt in 1883, its Origin and Hygienic and Quarantine Measures," by Dr. S. V. Decastro, Milan, Vallardi, 1884; and Professor Fauvel's report to the Academy of Medicine of Paris, "Bulletin de l'Académie de médecine," séance du 24 juillet, 1883.

† "The Cholera," by Max von Pettenkofer. The author's preface to the Italian translation, by U. Mosso, Turin, Loescher, 1885.

only means of prevention, and the latter in persistently combating these opinions, and studying nothing but the causal conditions of localities.

At present the question has taken on a new phase, which will be of great benefit, a current of attraction having manifested itself between the two doctrines as to the necessity of hygienic reform, and both contagionists and localists agreeing upon this essentially vital point. It is useless to enter here into details on the two doctrines; I will, however, keep close to the practical part of the question, in order to show, in as precise a manner as possible, what particularly interests our country, in which the cholera seems specially inclined to settle. I will make no allusion to certain important discussions, being sure that ample light will be thrown upon them, as well as on the facts observed, and on the practical studies just initiated. I believe that, without demonstrating if the microbe, or cholera germ, is precisely the one described by Koch, Emmerich, Pacini, or any one else, it must be considered to be one of those microscopic creatures, capable of reproducing itself in various degrees of activity, either in the interior or on the exterior of organisms, a fact which is demonstrated scientifically and experimentally respecting all pathogenic, infective, and diffusible microbes. This germ, if I may be allowed the comparison, has the quality of amphibious creatures, and will produce an epidemic if it can find the conditions necessary to its development in a non-hygienic center, or limit itself to single sporadic cases, when it only attacks single individuals who are predisposed to receive it, but who dwell in a comparatively healthy center. The condition of individuals such as those subjected to impure water and unwholesome nutrition, or to a disease such as diarrhea, etc., is favorable to the development of cholera. Other favorable conditions may be found according to circumstances of time and place, as explained by von Pettenkofer and other localists, and, at given periods, in any other circumstance favorable to the propagation of infective pathogenic microbes, due to unhygienic conditions of a particular place, and especially to the condition of houses in which the poor congregate and lead a miserable life; also to the nature of potable water and the manner in which it is conveyed; to river-water, if it runs slowly, and if the inhabitants employ it for domestic use; to the state of wells if they are sunk in porous soil, and if the level of the water is near a stratum of subsoil impregnated with organic matter; and to all other circumstances which are recognized to be injurious to life in general; besides which, the crowding of miserable individuals in filthy localities, and under certain influences, vitiated by unhealthyness, and the habits of large towns, all constitute in themselves a most dangerous center for the development and propagation of any infective disease, and especially of cholera. This is what I call a fertile and prepared field for the development of infective diseases. And I could bring to bear upon the subject thousands of facts, collected by myself and colleagues with the greatest care,\* during the epidemic which raged in Palermo and the bordering districts in 1885; but I stated that I should not enter into details here, and will refer the reader to my report on that epidemic, which is being printed.

All this which I admit respecting epidemics makes me at the same time both a localist and a contagionist, as I acknowledge and hold as demonstrated regarding epidemics that which

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\*During the epidemic of 1885 in Palermo, the "extraordinary municipal sanitary commission," of which I was the president, appointed, among its members, a subcommission composed of Dr. Sebastiano Reyes, Professor Giuseppe Coppola, and Professor Vincenzo Cervello, to collect all the information relative to that epidemic, and to ascertain the historic facts as to its propagation, with such documents and testimony as could be obtained. This commission at once issued a list of questions to all the physicians practicing in the place, and placed itself in communication with the local authorities. It was ascertained: 1. That cholera was imported into Palermo in 1885, and in the month of August, by the steamer *Solunto*, which came from Marseilles, and which had on board a slight case of cholera that was not declared during the quarantine undergone in the Gulf of Asinara. 2. That it was verified that the *Solunto* was the cause of two original centers of contamination. One was in Vicolo Cannata, at the Borgo, where the soiled linen of the crew of said vessel was washed, in consequence of which the first to be seized by the disease was the wife of a certain Ferri, on the 26th of August; and the other was in Vicolo Santa Cecilia near Piazza della Rivoluzione in the Tribunale quarter, where the linen of the firemen of the same vessel was washed, and not having been returned, was discovered when it had been already washed and hidden by a woman whose cousin, Giuseppe Spataro, was attacked by cholera on the 5th of September, and died on the morning of the 9th. 3. That the epidemic spread principally in Vicoli Cannata e Gilberto, at the Borgo, from family to family through contagion, and elsewhere on account of the persons who fled from the said places, or through linen which was carried away from the Vicoli and washed elsewhere.



has been proven by the artificial cultivation of pathogenic infective microbes. Virchow observed, in speaking about the glanders and hay bacilli, that in different periods and circumstances these bacilli possessed different degrees of virulence. Héricourt and other experimental hygienists\* have demonstrated the influence which surroundings exercise on the cultivation and propagation of the various microbes. In fact, every one knows that certain given influences change the conditions of life and activity, even among human beings of the most elevated classes.

In the artificial cultivation of microbes, by varying the intensity of the light, the degree of heat, the degree of humidity, the quantity of oxygen and other chemical agents, and subjecting the microbes to the influence of the same for a longer or shorter period, and by placing them in special broths and gelatins prepared for their cultivation, one obtains visible variations in the degree of activity of the germs under consideration, so that their virulent properties may be modified and even neutralized, as Pasteur and others have demonstrated with respect to cholera of fowls, anthrax, and "rouget" of swine.

In the present state of science, I am justified in considering my way of looking at and explaining the development of epidemics, which might seem an hypothesis, to be the true way. Héricourt says that it serves very well for the exact interpretation of facts, and that it would be acceptable, even if it were an hypothesis, as it does not go beyond the deductions which one can properly draw from facts established by experiments and from observations made on the causes of the attenuation and strengthening of virus, *i. e.*, of pathogenic infectious microbes.

Experience teaches us that epidemics cause greater destruction of life where hygiene is neglected, and that those places which have been visited by infective diseases, and especially by cholera, once purified by means of proper laws and sanitary regulations, have escaped the recent invasion of cholera. Thus, in Italy, the last invasion of cholera has by preference struck the most neglected spots, and will certainly continue to make havoc where nothing was done, or where that which was done was performed imperfectly, and regardless of common sense.

One must speak the truth, whatever it may be. During the last twenty-six years, in which Italy has been free, the Government has never occupied itself with public health. In certain towns there has been praiseworthy action, due either to individuals or to municipal majorities, but the country in general, as well as its Government, has been unable to think for itself. In many towns, and I will cite my native town, Palermo, everything was erroneous. Instead of purifying the city's public promenades, gardens, theaters, of which one, the "Massina," is still incomplete, useless public markets were made or erected. This was a great mistake, to the detriment of public health. Hygienic regulations were also erroneous, and the duty of keeping the town clean was intrusted to persons totally ignorant of the elements of hygiene, who, instead of promoting the public welfare, were the cause of public nuisances. When it was found necessary to suspend the noxious system employed, which caused public discontent to such a degree that open and serious demonstrations ensued, everything was abandoned, and, excepting the cleansing of the main street, matters were left to follow their own course.

After twenty-five years of existence, the famous *fondaci*† of Naples were discovered through the benevolence of the King, and in Latium, after twenty-six years, two ministers and a secretary-general discovered the famous *ortali*. And in order to discover this shameful state of affairs, great public calamities, the presence of a King and the humane visit of certain ministers were necessary!

The *fondaci* of Naples exist in Palermo under the name of *catodii*, in which a hundred thousand half-naked and starving inhabitants live in worse condition than animals. The

\* M. J. Héricourt, "Influence des milieux sur les microbes." "Revue scientifique," No. 17, October 24, 1885.

† The *fondaco* is that pestilential conglomeration of huts made of mud, without air and with little light, in which one-fifth of the Neapolitans take shelter at night. The *ortale* of Latium is a heap of refuse and dung accumulated and kept in bedrooms. The *catodio* of Palermo is a miserable hovel, made of mud, often without any sort of pavement, without windows, with barely any light, and in which the atmosphere can not be renewed, in which numerous half-naked and starving families dwell.

*ortali* of Latium are the dung-heaps of nearly all the houses of the smaller districts of the center of Italy. In Sicily, Napoletano, Puglie, Abruzzo, etc., animals dwell in the same rooms with the people who own them; the people live with their donkeys, cattle, poultry, swine, etc. In many places the refuse and excreta of both man and beast are allowed to accumulate in streets near the house; chamber-pots are emptied from the windows into the streets, and the person and linen are washed in river-water or the gutters, or open water-courses, which pass close to the dwellings. Many places lack potable water altogether, or have it conveyed to them in an impure state, so that it easily becomes contaminated, and organic matter, and rain-water in which linen is washed, find entrance.\* Either the houses in Italy do not possess water-closets, or those which do are without traps or hydraulic valves. I believe, without exaggeration, that one could count the houses which are supplied with water-closets. The closets generally consist of a pan, which is in direct communication with a cess-pool or with a most deficient system of drainage. In most districts public hygiene is but an empty name, and the cleansing of many towns is but a municipal pretense, and merely to keep some hundred persons from starving by employing them to sweep the streets, etc. Mayors, prefects, councils, and sanitary commissions allow matters which refer to the public health to slumber in peace, and what is worse, they have allowed, in a town such as Palermo, during the last twenty years, the erection of a new quarter, famous for its pompous name, the *Borgo Nuovo*, without municipal surveillance or hygienic precaution. Whoever visits that miserable slum is disgusted and goes away quite horrified. Houses are run up there without the slightest symmetry; the streets—where for the most part slops and refuse are cast—are made without conduits to carry off the rain-water, etc., and the inhabitants are huddled together with their animals. Public water is wanting there, and organic matter and putrefaction penetrate into the wells which supply drinking water to the people. Not only are the houses without light and ventilation, but the streets are real labyrinths through which it is difficult to pass on account of the accumulation of filth. It is needless to say that when an infectious disease visits such a slum it generally remains there for years, and that typhus and diphtheria never leave it. As might have been foreseen, the cholera committed immense destruction in this place during the last epidemic. The municipality is now thinking of reforming it, but there are no laws for that purpose. Who ever occupied himself with this subject? Who ever thought that about one-third of the population of Italy lived in miserable hovels? A newspaper has occasionally spoken on the subject, some philanthropists have revealed a part of these miseries, but they were allowed to talk, and things were left in the miserable condition in which they were found. When the scourge rages and cuts off thousands of lives, then it is that one sees a patriotic advance of charity. The King, ministers, ecclesiastics, and subjects of all parties and parts of Italy make a rush; every one then talks of the common woe, and enormous sums are scattered to assist the afflicted, for whom the riches of Cræsus and Solomon would not be sufficient. The King and the country sympathized when Naples suffered, and, instead of advantage being taken of the misery revealed by the calamity suffered by Naples, a great sensation was created, but it subsided upon the vote of a law to open and reform the drains. Why was so much pity bestowed upon Naples alone? Are there not many other places in Italy in the same condition? Why make a special law for one place and not a hygienic law to improve the sanitary condition of all Italy? It was thought that to extend some of the articles of the special law for Naples to certain other towns when they asked for them would be sufficient for the general requirement. We require a general law, but having to enact some kind, we pass a special one, without established principles, without precise understanding, and we issue this law to purify one single town! As a result of this law we shall obtain no good, but evil, for this is not a law which can be expected to purify the whole of Italy; it will probably not even purify Naples completely. It will certainly beautify and cleanse Naples, and will create an excellent precedent. But I doubt if the enlargement of

\* When it rains for two or three consecutive days in Palermo, the potable water reaches every house in a muddy state, on account of the defective system of conveyance, which is so badly organized that some conduits which are open are used by washerwomen for the cleaning of linen, etc.



streets and the building of new houses, without due attention being paid to the hygienic situation, will suffice to improve the sanitary condition of the place. For the improvement of the health of a place, laws are required to provide for general as well as private hygiene—laws which secure inspection of the interior of private houses, laws which control schools, hospitals, public buildings, workshops, mines, etc. In order to improve the health of a place and to maintain it in a proper condition, a well-regulated and organized service is also required, and such sanitary commissions as will cause these laws to be executed and can compel every one to obey the same, whether administrators or directors of public buildings, institutions, or factories, etc., or private individuals.

The law which I would like to see quickly promulgated in Italy exists in England. It was published in 1875 (Public Health, 38 and 39 Vict., 1875), and has been in force throughout the whole United Kingdom during the last ten years or more. During that time England has been free from cholera epidemics, notwithstanding her continual communication with India and with the whole of Europe, without the annoyance of such a thing as quarantine; typhus fever, scarlatina, and other infective fevers no longer exist in the form of an epidemic. I believe that the desire for a similar law will shortly become universal, and, if the present outbreak of cholera, with all its destruction, brings us this benefit, it will be a great gain. I trust that the Government and the representatives of the nation, at the opening of Parliament, impressed by the hygienic requirements of the country, will occupy themselves with the solution of this most important question, which has now become the subject of general interest.

The late Dr. A. Bertani, an illustrious compatriot, had prepared a hygienic code. It is urgent that this projected law should soon be published, so that competent persons may study and discuss it. The lives of thousands of subjects and the reputation of Italy are at stake. But I repeat, if the hygienic law is to aim at the improvement of the country through the banishment of epidemics, it is necessary that the houses should be seen to first of all, without which no general law will be efficient. Above all close attention must be given to the mode of construction of dwellings.

In conclusion, I will cite an instance which localists and contagionists often refer to, which strengthens their doctrine. At Fort William, in Calcutta, cholera reigned every year in the form of an epidemic, and cut off thousands of soldiers who were garrisoned there. This fort was a regular cholera center, and, as it is situated in a cholera territory, the hope of ridding the place of the disease referred to was almost abandoned. At present, however, that fort, which is still in the same place—viz, in the center of Calcutta, which is annually visited by cholera—has become quite free from the attacks of the disease. Localists say that this is due to the fact that the barracks were rebuilt according to hygienic laws and principles, and that the subsoil was rendered healthy by means of proper drainage. Contagionists, however, believe that it is due to the introduction of a new water supply which furnishes pure and filtered water. I believe this result was obtained by all that was done for sanitary improvement. And I only hope that in Italy every house and place may become a rock of health such as the famous fort of Calcutta.

The new law on hygiene and epidemics, of which the country stands in such need, no matter how much it may be desired or how quickly it may be put in force, can not by its simple publication purify the whole country as if by magic. Several years are necessary before it can produce beneficial results. We have now had cholera in our country for three years, and we have seen what the sanitary law of 1865 prescribes;\* we therefore feel the need of wise sanitary regulations, in order to arrest or avert the great danger which is ruinous to our country. Such

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\*The general sanitary law of March 20, 1865, and the regulations for the execution of the same, dated June 8, 1865, and June 22, 1874, do not directly provide for any sanitary system. The protection of public health is intrusted to the minister of the interior, prefects, underprefects, and mayors, and, with regard to epidemic and contagious diseases, Chapter II and part 4 of said law and the eighty-second and subsequent articles should provide, but, on the contrary, they do nothing of the kind; they simply hamper the authority of the minister, prefects, and mayors, with certain routine instructions. The country has witnessed how and when they can be of any use during the epidemic which has raged here for the last three years!

regulations, not less than the new sanitary law, should be based upon recent progress in science, so that, by improving the sanitary service, imparting knowledge, and rendering epidemics less destructive of human life, they may serve to facilitate the execution of the hygienic law. The urgency of such regulations is indisputable, and it ought not to be necessary for me to demonstrate the extreme necessity therefor.

The sanitary service of the kingdom, based upon the law referred to, is divided into two sections—external and internal services. Supreme authority is vested in the minister of the interior, who directly provides for the protection of health by means of maritime sanitary rules and indirectly for the internal sanitary service through prefects and mayors. The sanitary service in ports and coasts for arrivals from the sea is regulated by international convention, which for the most part has ceased to be in force on account of the disputes in the international quarantine commissions of Egypt and Constantinople, to which the sole line of defense against the approach of cholera from India was intrusted. The sanitary service of the ports is really intrusted to harbor-masters, who are assisted by a few doctors and guards. The service is generally limited to the issuing of bills of health and to admission to free pratique of vessels arriving. When a vessel comes from an infected or suspicious place, or declares disease on board of a suspicious character, then begin the duties of the port doctor, who, furnished with a gold-striped hat, inspects the persons on board. Passengers and crew are called on deck, and placed in straight lines against the bulwarks, and the doctor then examines them from a boat, which stands off at a certain distance. I have assisted at these sanitary inspections, and have also been subjected to them as a passenger on board. There is hardly anything more ridiculous, and on board it is an occasion of general hilarity. The sanitary inspection is methodically repeated at every port, and for vessels in quarantine it serves for the admission to free pratique. Recently mail steamers, which touched at various islands, were obliged to have a doctor on board, but they were poor doctors, chosen by the owners of the steamers; they have no authority whatever, and I therefore believe it to be a perfectly useless expense. I traveled on one occasion with a doctor on board, and I really was not aware of his presence. On another occasion the ship's doctor was one of my pupils, who had taken the matter very seriously, and wished to visit every one and expected the sailors to do their own washing every day. But the captain begged him not to worry people, which naturally cooled this young man's enthusiasm, who thought he was simply doing his duty. The *lazzaretti* for the undergoing of quarantine have been abolished, or at least those existing have been declared unserviceable, and quarantine is undergone on board, in a port or in a roadstead expressly designated by the minister of the interior.

It is needless to describe the laws governing quarantines as the very ancient ones for the pest are not yet officially abolished, and I am not aware of any new ones. Such a service is generally intrusted to a retired sea-captain and to sanitary guards who are as zealous as were the historic guards of the Holy Sepulcher. The duration of quarantines for the islands upon arrivals from the Italian continent is not fixed by any international agreement, neither is it established according to any law; it is, however, fixed by the minister of the interior, and does not generally satisfy the people. The Government often seconds the requests and occasionally refuses at the risk of disturbing the public order of certain places where it is firmly believed that quarantines are the sole safeguard. For these reasons many really have believed that public health in the islands was safe; but I believe that the cholera would have kept away even without the quarantines. The cholera developed in Palermo last year in spite of quarantines, and was imported by the steamer *Solunto*, which came from Marseilles, after having been subjected to seven days' quarantine in the Gulf of Asinara, and after having visited the ports of Leghorn and Naples in safety. I do not wish to speak of the inconsistency of the Government. This is solely to be attributed to the want of a sound sanitary law, in consequence of which, when quarantines and cordons are in force, fairs and troops are frequently allowed to move from place to place and from infected provinces to healthy places, which give rise to protests and complaints and cause public disorders, especially in those places where the contagionist theory predominates, where it is thought that cholera is ap-



proaching with the arrival of every vessel and the landing of passengers.\* The internal sanitary service, lacking proper laws and regulations, is regulated by ministerial circulars containing instructions to prefects, who afterward forward them to the mayors. Upon serious occasions sanitary councils take things seriously; they appoint commissions and draw up circumstantial reports, which are printed in order to become solemn testimony of the uselessness of such institutions regarding the protection of public health.† Municipalities protect public health by means of sanitary commissions, which do nothing but consult and assemble, whenever the mayor thinks fit, and the questions discussed are those chosen by that official. As a general rule, if the interests of some single individual are not involved, the discussions are simply academical and of no practical use. The municipal sanitary service is conducted by the official doctors, who in small communities are subservient to the mayor or to the party which is in power, and can be dispensed with much quicker than any other employés. They are employed outside of the common law, they have no privilege nor any right to a pension, they live miserably upon most meager salaries, and are also obliged to gratuitously attend to the aged. For some time complaints have been made of the unfortunate condition of these benefactors to public health, but the Government has not yet deemed it proper to remedy this enormity. And at the same time the official doctor could and should be the real sanitary officer of the kingdom. He could be the pivot of a hygienic law, while he is a reliever of human suffering. Many small towns are provided with hospitals founded by the charity of the inhabitants; but the most of those hospitals are in the worst hygienic condition, are badly administered, do not generally answer to the needs of the people, and are nearly all without separate wards for infectious diseases. The action of the proper authorities of such towns is often null, because the prefects, who should guide them, occupy themselves with political questions, and do not pay the slightest attention to the administration of charitable institutions. Some of the principal towns have lately established regular institutions for the assistance of the poor, and have, besides, erected offices and laboratories for the study of hygiene; but this is exceptional, for in general that which regards public health is in complete chaos, and many towns are without hygienic regulations,‡ small communities even ignoring the existence and meaning of the word "hygiene," so that contagious diseases are never attended to separately, nor are any preventive measures taken against typhus fever, diphtheria, scarlatina, or even small-pox, even if they assume epidemic proportions. The inhabitants are alarmed only on account of the cholera when it arrives suddenly and flares up with vehemence; sanitary services are then organized or improvised, and as isolation infirmaries do not exist, those attacked by cholera are often admitted into the hospitals which are intended for ordinary diseases, at the great risk of the sick and of the whole city, in which the only place assigned to the ordinary sick is in a moment transformed into an epidemic center. It is of no use to talk about the harm to public health and to the moral and economic management of a community caused by such a system. It often subjects the authorities to great expense, for, being pressed by need and frightened by the

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\* When this article was being printed the telegraph informed us of serious disturbances which had occurred in Palermo on account of the arrival of several vessels conveying disbanded soldiers to their homes, upon one of which steamers a case of cholera manifested itself while in quarantine. And in the Milan papers a protest appeared from the mayor, addressed to the minister, in which he remonstrated at the approaching arrival of a regiment of cavalry from an infected region.

† See reports on cholera by Professors Panteleo, Randacio, and Argento, approved by the sanitary council of Palermo in the extraordinary assembly of the 6th of January, 1886. Palermo, 1886. These reports were drawn up and approved by the sanitary council above mentioned, at the request of the prefect of the province, and at the desire expressed by the provincial deputation. It is an important work, which has the fault of not interpreting the will of the Government and of suggesting means and measures which are not in accordance with Government views; hence, like so many other works of a similar kind, it only shows the uselessness of the institution of provincial sanitary councils.

‡ Article 152 of the regulations for the execution of the law of March 20, 1885, on public health, prescribes that every district should have its hygienic regulations, and it enjoins those which have none to form them without delay, so that they may be published before the 1st of January, 1886. Nevertheless, many districts are still without any such regulations, and the city of Palermo, up to the 1st of January, 1886, had none whatever, and I do not believe it has them even at the present moment.

impending danger, they try to do in a day, by forming services in confusion which require prepared regulations and an educated staff, that which they never thought of doing at the proper time with a good sanitary organization, squandering public funds, thus giving proofs of their incapacity. Then experienced doctors are called whose learning was not appreciated at the proper time, and whose advice was once despised and had fallen into discredit with the vulgar, and their advice is accepted; or they hope for a repetition of the multiplication of loaves and fishes, expecting that with a badly organized and an inferior staff (which is a badly paid), insufficient for the ordinary needs, can be obtained extraordinary, serious, and delicate services which require energy, knowledge, and promptitude. Notwithstanding this, it is believed that when needed the assistance of municipal employees may be effective when these persons are vitiated by the influence of bureaucracy, or demoralized by electoral, political, or administrative contests, of which, lately, Italian municipalities have become agencies, either at the service of a party, or at the orders of a prefect, for the degrading and nauseating personal solicitation of votes and promises. The present epidemic has demonstrated the serious consequences caused by this system of remedying an evil when present.

Many places—among which are two large cities, Naples and Palermo—allowed themselves to be surprised by this evil quite unprepared. On the pretext of not alarming the public, several mayors refused to form any preventive organization, whilst some were dismissed because they refused to follow the instructions of prefects. In some places mayors deserted their posts and left the communal administration in the greatest confusion; carbineers and soldiers were obliged to act as doctors, nurses, and even undertakers.

It is a fact that in certain places the people refused to receive the assistance of their municipality or doctors, owing to the fear of contagion and the belief that the epidemic was due to poisoning. This popular prejudice is ancient, and finds its origin in that popular credulity against which, as Schiller wrote, “not even the gods have power.” Through the ignorance of the lower classes, cholera is easily taken for the effect of poisoning on account of the rapidity with which it increases and spreads, and the celerity with which it kills; and for such a belief in poisoning one can find a plausible pretext in the very febrile activity into which the proverbial municipal indolence converts itself. It is a fact that many municipalities which had never paid much attention to their administration suddenly rushed into all sorts of regulations, and immediately ordered abundant disinfections as soon as they saw a great calamity approaching. In order to protect public health they often exceeded the limits of assiduity; and the people, who are generally neglected and frequently ill-treated, suddenly perceiving that they were the subject of most assiduous care, observing that their misfortune increased with the multiplication of public services, and terrified by the general calamity, were unable to discriminate between good and evil, suspected something must be wrong, refused assistance, shut themselves up, barricaded the doors of their houses, and when one offered them any aid, replied, “Let me die in peace.”

Then, again, in the Sicilian provinces, where the saddest reminiscences of the persecutions and massacres committed by Declaretto\* are associated with the cholera, suspicion was partly based upon the hatred which existed between the governed and the governors. If the people in their misery and ignorance do not see the great difference which exists between the present Government and that of the Bourbons, whose fault is it? What has the Government done during twenty-six years to merit popular gratitude, especially in the southern provinces?

\* During the cholera in 1837, the Bourbons sent Declaretto to Sicily, and this famous tyrant overran the island with a flying squadron, and took advantage of a slight disturbance in Syracuse to establish a government of military terror in Sicily, which lasted without interruption until 1848. Courts-martial judged without loss of time, and sentenced the victims to be shot one after the other, and such was the rage and hurry to kill that in Bagheria, a small town near Palermo, a child of ten years was found among thirteen persons who were to be shot. The cholera was most destructive that year. In the province of Palermo alone 40,000 deaths occurred. Borghi, Di Blasi, and other Sicilian historians narrate most horrible accounts of the Bourbon who did all he could to increase the number of deaths. He seized this opportunity to persecute and torture some of our greatest patriots, and to snatch from Sicily every trace of freedom. This is why the people believe in poison, which they fancy the Bourbons scattered in order to render the island miserable, and to deprive it of every former privilege.



Perhaps indirectly many things have been done, but directly for the people nothing. They dwelt before in miserable wildernesses, and still live miserably in the same hovels, which with time have become more horrible than before. They formerly lived abandoned, and now, who takes any trouble about them, who succors them in their pain and misfortune? In Palermo, a town of 250,000 souls, there is a miserable hospital of 300 beds, of which one-third are reserved for the sick of the province, which contains more than 600,000 inhabitants. Many of the infirm among the poor have died in the streets of this city without assistance. Well, in this case, complaint is made against the administration of the hospital, which is almost a financial failure, and which plods along as well as it can, while no one pays any attention to it, and charitable societies and the municipality sleep quietly and profoundly.\*

Popular beliefs are not easily overthrown, and in order to correct them, shouting and swearing are not sufficient, but a series of benevolent actions † to relieve misery is necessary; and with a view to stamping out the belief in poisoning during epidemics and especially during the cholera, a public sanitary system should be organized to work also in ordinary times against all those other contagious diseases which destroy thousands of lives daily without the slightest preventive measure being taken. When the municipality and the Government take care of public health properly, and with judicious regulations, the people, realizing that their health is really protected and their condition ameliorated, will cease suspecting and will recognize good where they now fear evil. Consequently in Italy, and especially in the south, that popular belief will gradually disappear. Until the Government thinks of reorganizing sanitary systems, the authorities will only waste their energies and public funds, and the Government may cease issuing instructions which the people either do not want or will refuse. By trusting to sanitary circulars suggested by the various sanitary councils of the kingdom, issued by the minister of the interior to hygienic councils, ignored with that callousness of Italian municipalities which somewhat resembles Arabian fanaticism, Italy will always be devastated by epidemics; cholera will remain for many years to come; and typhus fever, scarlatina, diphtheria, and small-pox will assume a permanent epidemic character! We are laboring under the greatest misapprehension, and are liable to incur the greatest danger, if we believe that committees of assistance and voluntary bands of nurses will be sufficient in time of need! Certainly the acts of charity performed by so many persons are to be admired, and are worthy of public praise. The charity of the King and people has really been touching, and has tended in some measure to alleviate a public misfortune, and it is therefore to be lauded; but certainly the works of piety and charity are not enough to regulate public services, nor can they be of any use in protecting public health.

To this sacred end the Government should enact wise laws, and municipalities create efficient organizations. In a country where liberty was longed for, and which made so many sacrifices to bring about a union, it is a duty of the highest importance to protect public health. The ancient Romans, who were skilled in the handling of arms, and more advanced in civilization than any other nation in those times, vigorously protected public health, and placed it at the head of everything—*Salus publica suprema lex esto*; with healthy citizens who were neither dejected nor degraded by great epidemics, they conquered the world and civilized it. At the present time hygienic laws and sanitary provisions against epidemics in Italy are a duty of civilization, a duty of humanity, and a political and moral necessity.

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\* Lately the municipality organized the service of visiting doctors, but in spite of their efforts it is very certain that they can not cure certain diseases in the miserable dwellings of the poor, where light, air, and frequently even bedding, do not exist, and in which animals also live.

† During the last twenty-five years I have always tried to improve the hospitals and ambulances as much as possible, as well as the miserable condition of the sick and wounded, and so far as my strength has allowed me I have always taken great interest in the poor. In 1866, with the assistance of some friends and charitable ladies, I caused a ward in the Civil Hospital to be set apart for sick children; and in 1874, with the help of the same friends and ladies, I worked to found in Palermo a hospital for children, called the Ospizio Marino. Whenever I could, I have always endeavored to convince the municipality and province of Palermo of the necessity of helping the poor. If in the last epidemic which raged in Palermo I was listened to by the poor with reverence and affection, it was partly due to my colleagues in medicine, who always understood and assisted me in my honest endeavors, and partly to the gratitude of the people for the little which I had done for the benefit of the poor.

It appears to me that I have clearly demonstrated two important facts, viz, the very bad state of sanitary organization, and the necessity of remedying it at once. Sanitary bureaux should be established for the protection of public health, as well as for the protection of persons and property; and those so called organizations of sanitary councils and municipal health commissions should be abolished because, on account of the defective manner in which they are organized and the class of persons which the law requires they should be composed of, they can not intelligently direct the hygienic and sanitary service of the kingdom. Prefects and mayors should, for the protection of public health and the effective working of the various services, have a sanitary bureau attached to their own, with the necessary means for the conduct thereof. The Government should at once assemble a commission composed of the most eminent hygienists and practical physicians, with a view to projecting a reorganization of sanitary systems. In my opinion, for such an important service, Italy should be divided into various urban and rural districts as England is. In every district there should be a hygienic and sanitary commission, which would be controlled by the local authorities, with various inspecting physicians and an adequate number of sanitary guards, who should be educated and capable of discharging the duties required of them. Every district commission should be supplied with a laboratory for hygiene and one or more high pressure steam apparatus for the disinfection of linen and bedding. Large cities could be divided into several sanitary districts, according to the number of inhabitants. Experienced visiting physicians should be appointed sanitary officials, under the district sanitary authorities, for everything pertaining to the public health. Civil and military hospitals in times of epidemics should be placed under the care or superintendence of the respective district commissions for the execution of hygienic or preventive measures. District commissions should be obliged to superintend every sanitary service, to execute or cause to be executed, hygienic repairs in houses, especially among the poor, in public buildings, etc., whenever infectious diseases break out (small-pox, diphtheria, typhus fever, typhoid fever, scarlatina, cholera, etc.), to provide for the necessary disinfection of places and effects belonging to the sick, and to cause every patient to be isolated.

Reiterating what I have already said of the necessity of a law on public hygiene, and of the urgency of public regulations, I will finally treat practically of the question of prevention in times of cholera. Of course the precautionary measures will vary according to acceptance of the localist or the contagionist theory. Apart from the fact that both theories have much in common, as I have always said, we should consider the question of prevention as purely practical, and we should, therefore, make use of the results which have lately been obtained by study and pathological experiments. We have already shown that cholera is carried with people and merchandise, and that for the development of the disease both places and persons must be predisposed. If one of these conditions is wanting, the epidemic remains stationary. Preventive measures should therefore be adopted, together with sanitary steps, and should regard at the same time commerce and local and individual predisposition. Preventive measures against the spread of cholera by means of cordons can not possibly be executed, for then every avenue of the country and all communications would have to be closed up.\* It is almost useless to argue as to the efficiency of quarantines with regard to Italy, which is at present invaded by the cholera; for this a complete international agreement would be necessary. If we consider this question practically, it can only affect the islands, which are at

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\* It is well to know the ideas in vogue with English physicians who are connected with the Indian sanitary commission, in order to see the difficulty of an international agreement for quarantine. Cunningham, who is the at the head of the medical department and sanitary service of the Indian Government, and who is well known and greatly respected on account of his studies on cholera, is of opinion that commerce, which has been so much accused, is not such a sure means of communicating cholera as was at first supposed, and he proves, by means of a series of experiments and facts, that commerce has little or no influence on the propagation of cholera, and that quarantines must disappear, being useless and dangerous barriers. Those countries which are directly and frequently in communication with India are the ones which have suffered the least, and from the time that this communication became more rapid and direct, western countries have suffered less than they did before. (Cunningham, "Cholera: What can the state do to prevent it?" Calcutta, 1884.) [The so-called proofs and deduced opinions of Cunningham have been shown in another portion of this report to be erroneous.—E. O. S.]



present free from cholera. With regard to the islands, they can perhaps be protected by means of quarantines, but one must also consider that it is necessary that these quarantines should be arranged in such a manner that commerce be not altogether obstructed, and in that way there can be little safety. In fact, the islands have frequently asked for the imposition of quarantines as a precaution, but the cholera has entered notwithstanding and has caused more destruction than in continental towns.

If quarantines are to be maintained, it is necessary to establish them on new principles; their duration should be fixed at seven days, and hygienic measures should be employed, such as airing, ventilation, and disinfection by means of compressed-steam ovens, etc. Such measures must be considered as indispensable parts of quarantines, as the latter without the former are quite useless. Quarantine should begin after a medical visit, which should be repeated daily. Admission to free pratique should be given only after an accurate hygienic inspection, and after the disinfection of the linen, and the opening and airing of baggage and merchandise. It is necessary to provide two *lazzaretti* for the islands, furnished with suitable infirmaries for the isolation of the sick, compressed-steam ovens for disinfection, and space enough for the opening and airing of baggage and goods. Quarantine on board might be allowed only to arrivals from infected places, so long as there were not too many passengers on board, and vessels should be provided with steam ovens, and have a doctor appointed by the Government. When a case of sickness manifests itself upon a vessel, either during a voyage or in quarantine, the vessel must be thoroughly disinfected, and her bilges emptied and washed with a solution of corrosive sublimate or with sulphuric acid. During an epidemic the rag trade must be prohibited, and at the cessation of an epidemic the trade in question must not be renewed until the rags are disinfected in ovens. In or near infected places we must also prohibit fairs, the changing of quarters of a garrison, or any other transfer of troops, or military maneuvers, levies, transferring or discharging of classes, etc. In places which are menaced, hospitals and public institutions must be isolated, and special places must be got ready for those attacked by cholera, as well as places for the isolation of those persons who were living with the first attacked by the disease. In every train a separate car must be set apart for the sick, and stations must be furnished with the means necessary to their transport. The cars in which cases of cholera manifest themselves should be disinfected and washed with a solution of corrosive sublimate in the proportion of 1 to 2,000.

This certainly will not be sufficient to altogether prevent the cholera from entering a place, and therefore the greatest attention must be given to the locality. Mayors and sanitary commissions must promptly have any cause of insalubrity removed; they must see that potable water is not polluted, and inspect public washing places and public works; they should see to the thorough cleanliness of the streets and houses, by causing any organic matter or refuse to be promptly carried away; and must advise people to keep their closets clean, and disinfect them daily with solutions of chloride of zinc in the proportion of 25 to 1,000, or with sulphate of copper, 20 to 1,000; they should also carefully isolate the first cases of cholera, and keep their sanitary staff always in readiness. It is also necessary that individuals take good care of themselves, especially if they are predisposed to illness. Predisposition in this respect may be injurious, as are impure air, scarce and unwholesome food, impure water, chilling of the body, and any excess which affects moral and physical strength; consequently wholesome nourishment, pure water, and flannel clothing, or at least the covering of the stomach with a piece of flannel, avoiding diarrhoea, and seeking the doctor's advice when any indisposition is felt, are absolutely necessary. If there is doubt as to the quality of the water, it can be filtered by means of porcelain filters (such as Chamberlain's and Mialhe's), or boiled. Physicians can prevent many misfortunes when they are called in time; besides, it is as easy to cure the first symptoms of the disease as it is difficult to cure it when it has made progress. Do not trust in so-called specific remedies brought forward by charlatans, and refuse the use of new remedies in a disease which gives such little time for experiment. The essential advice for personal protection is to keep the person and the house extremely clean. During the epidemic which raged in Palermo in 1885, the sanitary commission of this town strongly advised the people,

by means of various publications and insertions in the papers, to strictly adhere to the precepts above mentioned. Although the cholera was severe—having after the ninth day killed 192 in one single day, and in two months 2,710—among the higher classes, who were able to follow the advice of the sanitary commission, there occurred but few cases and not more than 30 deaths; whereas the disease caused great destruction among the poor, who were either unable or unwilling to follow any advice.

I trust that municipalities, provinces, and the Government will consider what I have briefly advanced in the present communication, and will reflect upon the very serious results consequent upon the want of proper hygienic laws and well-regulated services. Regarding the “conditions of time and place” which, according to the localists, prepare the way for epidemics, facts should be cited. They will form the best arguments and inducements to urge the reformation that I have mentioned. In Wales, von Pettenkofer says, 50,000 deaths occurred from cholera in 1849, 20,000 in 1854, and 14,000 in 1866. From that time the cholera disappeared from that region, and in 1867, 1870, 1873, and 1884 there did not even occur one case. Whereas in Naples, according to Spatuzzi, in 1873 there occurred 1,000 deaths from cholera and in 1884 more than 8,000; and in Palermo, in 1866, there were 4,000 deaths, and again 4,000 in 1867, and 2,710 in 1885, which is the reverse of that which happened in Wales. Thus the result in Wales must be due to the hygienic reforms introduced into the houses of the poor, and to the pure, potable water with which that extensive district has been supplied. I trust that Italy will be able, without compelling municipalities to incur heavy expenses, to do in a few years that which they have failed to do in many years; and I trust in the skill of Italians, expecting that they will be able to deduce a public benefit from a sad experience.

The following table, containing the various numbers of deaths from cholera which have occurred during the last half century in Naples and Palermo, shows: 1. That the mortality from cholera in Palermo, taken altogether, exceeds that of Naples by 3,138. 2. That the percentage of the Palermo total of deaths is more than double that of Naples. These figures will help to show that the special law for the improvement of the sanitary system of Naples, originating in a sentiment of pity which does honor to the country, will be a gross injustice if it is not followed by a hygienic law for the whole of Italy; moreover, various important towns and innumerable districts bear the same relation as Palermo to Naples.

*Table showing and comparing the mortality from cholera during the various epidemics in Naples and Palermo.*

Year.	Population.	Duration in days.	Total of deaths.	Percent- age.
Palermo:				
1837.....	176,752	126	27,004	15.62
1854.....	182,270	95	5,334	2.93
1855.....	182,411	84	1,420	0.78
1866.....	200,012	100	4,046	2.02
1867.....	197,543	135	3,821	1.93
1885.....	244,901	89	2,710	1.10
Naples:				
1836.....	437,563	91	5,963	1.15
1837.....	432,720	154	11,714	2.71
1854.....	442,505	71	9,600	2.17
1855.....	434,050	107	1,300	0.30
1865.....	444,880	70	2,200	0.49
1866.....	442,804	85	3,470	0.79
1867.....	441,007	68	300	0.07
1873.....	457,530	116	1,280	0.28
1884.....	495,788	91	5,370	1.08

There have been six epidemics in Palermo during forty-nine years, the total number of deaths being 44,335, and there have been nine epidemics in Naples during the same period, with a total loss of 42,979. The proportion of deaths to population at Palermo was 1.80 per cent., and at Naples 0.86 per cent.



## SEWERAGE AND DRINKING WATER OF THE CITY OF TURIN.

A fair notion of the usual hygienic condition under which the masses of the whole population of Italy live may be found from the following abstracts of an official report recently published by the Italian Government, and of a memoir by C. Calandra.

In a memoir "Upon the sewerage and drinking water of the city of Turin," C. Calandra gives some account of the hygienic conditions of Turin and some other large cities in Italy, of which the following is an abstract:

*System of irrigation in Italy.*—Milan is traversed and surrounded by the Naviglio Canal, the Inner Ditch, and the Seveso Canal; these at their exit, on the southern side of the city, unite and form the Vettabbia Canal.

These canals, for the most part uncovered, collect the dirty household drainage and fecal matter from an infinite number of houses, and this material, diluted by a large quantity of water, serves to irrigate the surface of thousands of *ettari* of meadow and marsh land in the neighborhood of the city. This irrigation produces wonderful crops of vegetables and hay, which are collected seven or eight times a year. The right to use this material, as may be well understood, commands the highest prices.

During the warm season the water containing this material irrigates the meadow land at intervals; but during the rest of the time it floods the meadows and flows among the vegetables, which, on account of the mild temperature of the water, continue to grow even in the less cold months.

Although this water deposits a solid organic sediment upon the surface of the meadows, it by no means causes emanations injurious to public health, as is proven by the experience of five years.

At intervals of a few years, the deposit thus formed is removed, not because it has formed an impermeable covering upon the ground, as was asserted in a certain discussion at Paris, but because the surface of the ground becomes elevated, and the level is thus altered.

The material removed is sold at a high price as manure, and the formation of a new deposit is thus provided for.

The water which traverses this section does not penetrate the ground, but throughout the long course which it takes among the vegetation, deposits the fertilizing principles which it contains, and finally empties into the Lambro considerably purified. In this system of Milan, inasmuch as the irrigation is somewhat limited, there is no contamination of the deep layer of ground water, which was feared at Paris, and there is consequently no danger to the public health.

In Milan the other elements of security are unfortunately wanting; the drinking water introduced into the houses is liable to contamination; on the other hand, the whole subsoil is traversed by sewers, with badly-built walls and unpaved bottoms, which receive the drainage from the houses and allow it to escape into the surrounding earth. Furthermore *pozzi neri* (sinks) exist in immense numbers, and the wells of drinking water indirectly communicate with the former by percolation.

Novara turns all of the sewage of the city into canals which empty into the moats of the ancient fortifications, and, mingled with the water which the latter contain, it is conducted to the meadows at some distance from the city, and the public health has not suffered in the least from this system. There is no public drinking water distributed under pressure.

*Irrigation in Turin.*—The city of Turin was at the commencement of this century almost in the same condition as Novara. A derivative of the Dora supplied the water necessary for the moats of the fortifications. Numerous branches of this stream were directed through the streets of the city, and at intervals it was made to flow in greater volume alternately in various streets, thus procuring great cleanliness.

Latterly the various canals through which this water flowed, forming a net-work which embraced the city from west to east, were walled and converted into sewers for the collection of the household slops and the overflow from the latrines of the houses along the streets. The rain-water was carried off by other canals (*canali bianchi*), which either were located above the sewers, or ran separately at the sides of the streets.

Almost all of these canals emptied into a general collecting sewer, called Bealera Nuova of Vanchiglia, which, starting from the iron bridge, runs parallel to the Po, along Rocca and Vanchiglia roads, and empties upon the meadows of the suburbs. But by lateral trunks and existing smaller branches a part of the water empties directly into the river, a little above the stone bridge. Another trunk emptied into the Moschino. The canal of the Consolata, covered, and changed from its ancient course, starts from the district of Portasusa, and runs diagonally towards the east to connect with the Molassi Canal, and to join the other sewage water to Vanchiglia.

Before the construction of the new sewers of Vanchiglia this material was used for the irrigation of the meadows lying to the south of the S. Maurizio road, and dried manure was made from it in certain broad ditches. But the ditches were filled up for hygienic reasons, and with the growth of the suburbs the irrigation was partly suppressed and partly removed to a greater distance from the city, but the industry of manufacturing manure was prohibited. The irrigation canals existing in the meadows were enlarged, and from them, at times, in the late afternoon, a disagreeable fetor invades the streets of Vanchiglia. The sewers aggregate 17 kilometers in length, whilst the conduits for rain-water aggregate 54, and are for the present sufficient for the needs of the city.

*Introduction of sinks.*—Unfortunately, in May of 1860, the council proposed a new regulation for the collection and disposal of household slops and of fecal matter, requiring, among other things, that the sinks should have a depth of not more than 8 meters, in order that they might be emptied by the new system. I refer to the new invention, a system of emptying the sinks by atmospheric pressure, which is done either by means of an iron cask into which the contents of the sinks are drawn by aspiration, or by means of aspirating-pipes which answer the same purpose.

The council did not even discuss this important matter, but at once inconsiderately approved the regulation, which, without taking any account of the drinking water which was then introduced into Turin, had for the city the gravest consequences in the substitution for a rational and hygienic system already existing, and which admirably preserved the character of the drinking water, another system which, on the contrary, was already condemned by hygienists, and which at this time has been generally proscribed.

I limit myself to presenting a few reasons.

I have already said that the fecal matter and the dirty water accumulate in the *pozzi neri* and remain there months and years, exempt from the action of atmospheric currents which could oxidize them. In a few days, therefore, decomposition takes place, and those terrible odors, which are so keenly perceptible in all of our houses, are given off. If the temperature which prevails in the sinks is high, and that of the upper air is low, a continuous current ascends through the pipes of the latrine, which has no trap. Suppose there is a case of typhoid fever or of cholera in the house, the ascending miasms from the dejecta may affect all the inhabitants of the dwelling.

In our system of sewerage, on the contrary, according to modern custom, the pipes of the latrine connect with a pipe in which there is an open flow of water which aids the discharge of the matter and also intercepts the ascending air current from the collecting-sewers to the interior of the house.

If, then, a sufficient quantity of water flows in the sewer, a matter which is indispensable, all the material continues to be carried off before it can deposit and decompose, and there are no emanations prejudicial to health.

Unfortunately the sinks of the city are not all in the condition prescribed by the regulations, and all have their very great inconveniences.

All the sinks of the ancient city are, for the most part, deeper than 8 meters; they can not, therefore, be emptied by the system of atmospheric pressure, except partially, because the atmospheric pressure can not be practically utilized at a depth of more than 8 meters. The upper, fluid part of the contents of the sink is extracted, but the solid decomposing matter remains at the bottom.

Many of these sinks of ancient construction are in bad condition. On account of their



walls being constantly subjected to an outward thrust when they are full, and, at other times, to an inward thrust from the surrounding earth when they are empty, the walls become ruptured, and lose the liquid matter through the cracks; besides, little by little, the solids form, with the gravel of the subsoil, a concrete which is certainly not calcareous.

But what has happened in many cases has served as a lesson, and an immense number of sinks have been consequently constructed with a considerable depth without a paved bottom, so that the material becomes diffused in the gravel of the subsoil, thus saving the expense of emptying.

The regulation which prescribes only 4 meters of distance between the sinks and the wells for drinking water, constitutes, therefore, absolutely no guaranty for the purity of the water. Many other sinks are constructed in such a manner that when the matter rises to a certain level, it escapes into the street sewer by means of a pipe. These are the worst sinks, never being emptied; there always remains in such sinks a large volume of foetid matter, never removed.

The regulation sinks have yet other inconveniences. Those limited to 8 meters contain little matter, and cost considerable for their frequent emptying. This, therefore, constitutes a great obstacle to the sale of the drinking water which is met with, since the proprietors of the houses in which they exist object to an increase of house-water which goes to the filling up of the sinks, for it has no value as a fertilizer and does not lessen the expense of emptying.

At my request the municipal board of health has caused an inspection to be made by its agents concerning the sewage, the number of sinks, and their condition. The facts thus obtained speak for themselves:

Number of houses in the city and suburbs.....	2,525
Number of connections with the sewers.....	1,024
Entire number of sinks .....	3,209
Regulation sinks of 8 meters or less depth.....	1,096
Sinks of more than 8 meters of depth.....	1,805
Sinks without paved bottom .....	657
Sinks emptied by the system of atmospheric pressure.....	2,126
Sinks emptied with the ancient system of buckets.....	1,002

We have, therefore, more than 2,000 sinks which either have at the bottom a perpetual deposit of corrupt matter, or, worse, a diffusion of this into the adjacent gravelly soil; hence, the entire city, and even those magnificent edifices of our new Turin, have in their internal recesses a canker, and our city, cleanly and beautiful externally, may be compared to a gracious lady with a fearfully smelling breath.

ABSTRACT OF A REPORT CONCERNING THE RESULTS OF INVESTIGATIONS MADE BY THE ITALIAN GOVERNMENT RESPECTING THE HYGIENIC AND SANITARY CONDITION OF THE COMMUNES, PRESENTED BY THE DIRECTOR-GENERAL OF STATISTICS.\*

In a circular issued on the 9th of January, 1885, the minister of the interior demanded from all the communes in the kingdom information concerning their hygienic and sanitary condition, through a series of questions drawn up by the superior council of health in concert with the superior council of statistics. The responses of the communes were examined by the provincial and municipal councils, and were transmitted by them with appropriate remarks to the minister of the interior, who turned them over to the director-general of statistics.

The information should have been sent to the minister not later than the month of April, but the majority of the provincial councils were several months behind in completing their work of revision, so that it was not until August that they came to hand for analysis. Responses from ten communes, among which are Naples and Messina, are still wanting.

It must be confessed that the responses given by the communes are in many respects vague and inconclusive; however, the information obtained from these, together with that which the central Government was able to procure from other sources, serves to give a suf-

\* Il Colera in Italia, negli anni 1884 e 1885, published by the Italian Government.

ficiently exact idea of the condition in which Italy was found as respects hygiene and sanitation.

The present report will comprise only part of the information obtained by the inquiry, viz, that which relates more strictly to hygiene and to sanitation; later, an account will be given of the information which more particularly concerns the topography and climatology of the separate districts.

It should be understood that the statistical results which we publish are to be regarded as preliminary; some slight alterations may be required when the revision shall be completed.

## DRINKING WATER.

I. A reliable opinion concerning the quality of drinking water can be pronounced only from chemical analyses, often repeated under diverse conditions. At the present time scarcely 318 communes of the kingdom declare that they have made chemical analyses of their own drinking water. Based upon the results of these, it appears that 198 communes state that they have good water, 85 mediocre, and 35 bad water.

All the other communes base their declarations, with respect to the quality of the water, upon a general judgment which they have been able to form from the freshness, limpidity, and taste of the water. These data should therefore be received with much reserve. The following table is a résumé of the responses concerning the quality and quantity of the water of the communes of each department:

Departments.	Number of communes which have drinking water.						Percentage of communes which have mediocre or bad water.
	Good.		Mediocre.		Bad.		
	Suf- ficient.	Scarce.	Suf- ficient.	Scarce.	Suf- ficient.	Scarce.	
Piedmont.....	1,216	105	96	39	14	16	11
Liguria.....	230	42	12	11	5	2	10
Lombardy.....	1,437	127	226	29	58	19	18
Venetia.....	580	52	72	26	31	28	20
Emilia.....	186	21	63	18	18	16	36
Umbria.....	100	21	10	10	3	8	20
Marches.....	177	16	20	24	3	8	22
Tuscany.....	177	24	37	23	9	7	27
Latium.....	163	21	16	19	1	7	19
Abruzzo and Molise.....	310	80	20	23	9	11	14
Campania.....	444	78	31	24	21	14	15
Apulia.....	145	22	45	10	7	7	29
Basilicata.....	99	13	2	4	1	4	9
Calabria.....	297	55	20	15	8	12	14
Sicily.....	229	80	12	18	5	11	13
Sardinia.....	219	29	46	28	24	18	32
Total (in the kingdom).....	6,009	786	728	321	217	188	18

There are, therefore, 1,454 communes which admit having only bad water, or at best mediocre, and of these, 509 have a scarcity in quantity.

The greater number of communes which declare that they have bad or mediocre water are found, relative to the total number of centers of population, in Emilia, Sardinia, Apulia, Tuscany, Marches, and Umbria.

II. Respecting the derivation of the water, it is to be noted that 2,739 communes obtain it from natural springs; 1,591 from common or artesian wells; 167 make use exclusively of rain-water collected in cisterns; 126 use running water, that is, from rivers, streams or canals; 1,722 use in part well-water, and in part water from natural springs; 413, well-water and rain-water; 425, well-water, rain-water, and water from natural springs; 360, rain-water and water from natural springs; 630 use running water besides, and 50 lake-water besides; 26 communes have not declared what kind of water they use for domestic purposes.



Classifying the drinking water of these various sources into good, mediocre, and bad, according to the declarations made by the communes, we have the following data:

Origin of drinking water.	Number of communes which use drinking water.		
	Good.	Mediocre.	Bad.
From natural springs .....	2,512	160	67
From wells .....	1,142	333	116
Rain-water collected in cisterns ..	96	54	17
From wells and springs .....	1,495	179	48
From wells and rain .....	299	75	39
From wells and springs and rain ..	343	60	22
From springs and rain .....	265	75	20
Exclusively running water .....	93	13	20
Partly running water .....	489	89	52
Partly lake water .....	43	5	2
Of unknown origin .....	18	6	2
Total .....	6,795	1,049	405

It should be remarked that well-water may be easily contaminated by filtration of fluid material from adjacent sinks (*pozzi neri*); as, indeed, running water may be fouled by sewers emptying into it, or by the products of industrial establishments, or it may be contaminated through the irrigation of the fields, and the maceration of flax and hemp; and many are the communes which make use of such water for domestic purposes. It is probable, therefore, that they have been too optimistic in their declarations that the drinking water used was good.

III. In 2,720 communes, the drinking water is brought to the towns from a greater or less distance by means of closed conduits of masonry or cement, or by metallic or wooden pipes; in 447 communes the conduits consist simply of open canals, in which the water may be easily contaminated by extraneous material; in 5,082 communes the water for domestic use is obtained directly from wells, or from natural springs, or from running water at a distance of several kilometers.

IV. The fact should be noted that 614 communes make use, in whole or in part, of leaden pipes for the conveyance of the water to the town, or at least for its distribution to the houses.

The following is the information obtained concerning the conduits of drinking water:

Departments.	Number of communes in which the water is conveyed to the town.		Communes which use leaden pipes as conduits, or for internal distribution of the drinking water.	Departments.	Number of communes in which the water is conveyed to the town.		Communes which use leaden pipes as conduits, or for internal distribution of the drinking water.
	By closed conduits.	By open canals.			By closed conduits.	By open canals.	
Piedmont .....	376	123	259	Abruzzo and Molise ....	236	19	4
Liguria .....	124	7	70	Campania .....	245	22	3
Lombardy .....	462	89	52	Apulia .....	28	2	2
Venetia .....	157	95	18	Basilicata .....	62	4	.....
Emilia .....	47	2	25	Calabria .....	204	34	1
Umbria .....	97	5	13	Sicily .....	199	23	18
Marches .....	112	6	30	Sardinia .....	55	3	6
Tuscany .....	165	3	74	Total .....	2,720	447	614
Latium .....	151	10	39				

#### STREETS AND HOUSES.

I. Three thousand seven hundred and thirty-seven communes declare that they have all of the streets in the dwelling part of the town paved with large stones or small pebbles; 1,802 others have the streets completely macadamized; 1,475 have them in part paved and in part macadamized; and finally, 1,235 communes have furnished no information in this regard.

II. Eight hundred and sixty communes are furnished with a pretty complete system of

sewerage throughout all their streets, or at least throughout the principal streets in the densest part of the population; 1,009 other communes are supplied with only one sewer, or a few among the principal streets; 4,877 are totally without sewers, and 1,503 do not furnish information of any kind, but it may be regarded as very probable that they belong to the category of communes in which there is no sewerage.

III. With respect to the cleanliness of the streets, 1,074 communes declare that they award this service by contract to a director, who performs his duty under the supervision of the communal authorities; in 3,172 other communes, the municipal authorities attend to the cleanliness of the streets by means of hired laborers; 2,327 communes leave the cleaning of the streets to the proprietors owning the houses upon them, who are careless, and consequently the service in those towns is neither regular nor sufficient; 579 communes confess that they do not undertake the cleaning of the streets themselves, and have not obliged the proprietors to clean them; and finally, 1,097 communes give no response to this question, but they may be regarded as belonging to that class in which the cleaning does not take place with much regularity.

IV. The dirt swept up from the streets is generally collected into heaps and removed to the stables to form manure, which at stated periods is transported to the country for the fertilization of the fields.

It is to be deplored that both the sweepings and the manure are often not deposited at a sufficient distance from the dwelling to allow of the dispersion of the deleterious gases which form in the process of fermentation. And, moreover, contamination of the drinking water by filtration into the adjacent wells may easily take place.

Three thousand seven hundred and eighty-one communes declare that the sweepings and the manure are deposited far from the dwelling, at a distance required by the rules of hygiene; 2,172 others, on the contrary, confess that these deposits are often too near; and 1,047 declare that the manure and the sweepings are usually found in the courts of the houses, or along the streets, piled up in front of the doors of the houses; finally, 1,249 communes give no response to this question; it is supposable that their condition leaves something to be desired in this respect.

The foregoing data are tabulated as follows:

Departments.	Number of communes which have streets—				Number of communes which have—				Number of communes in which the cleanliness of the streets is provided for—					Number of communes in which the sweepings and the manure are deposited—			
	Paved.	Macadamized.	Part paved and part macadamized.	Communes which do not furnish this information.	Sewers in nearly all the streets.	Sewers in one or a few streets.	No sewers.	Furnished no information about sewers.	By contract.	By the municipality.	By the proprietor.	No provision.	No information furnished.	Far from the dwellings.	Near the dwelling.	Within the houses, in the courts, or in the streets.	No information furnished.
Piedmont.....	847	253	162	224	76	98	1,083	229	274	260	525	126	301	537	300	254	395
Liguria.....	121	41	44	96	33	30	205	34	34	72	155	11	30	118	89	28	67
Lombardy.....	1,069	345	201	281	222	145	1,041	488	511	478	584	97	226	835	401	382	278
Venetia.....	57	448	99	185	61	49	489	190	22	528	88	74	77	302	261	71	155
Emilia.....	136	84	25	77	104	49	69	100	32	193	20	18	59	147	120	36	19
Umbria.....	62	17	57	16	25	43	71	13	5	119	6	3	19	82	46	...	24
Marches.....	129	41	52	26	74	81	72	21	4	206	9	11	18	140	79	13	16
Tuscany.....	149	52	60	16	110	77	65	25	34	187	27	18	11	157	86	27	7
Latium.....	120	16	83	8	27	74	125	1	33	154	22	3	15	128	85	4	10
Abruzzo and Molise.....	199	73	144	37	16	70	332	35	5	201	147	39	61	219	127	41	66
Campania.....	268	106	175	63	52	110	392	58	30	285	139	55	103	384	124	32	72
Apulia.....	73	52	92	19	12	38	149	37	50	118	23	6	29	166	44	5	21
Basilicata.....	72	12	35	4	...	13	103	7	3	29	74	12	5	80	38	1	4
Calabria.....	173	75	105	54	9	55	308	35	2	131	178	42	54	184	126	39	58
Sicily.....	144	89	90	32	31	67	106	151	32	190	66	20	47	208	100	12	35
Sardinia.....	118	98	51	97	8	10	267	79	3	21	264	44	32	94	146	102	22
Total.....	3,727	1,802	1,475	1,235	860	1,009	4,877	1,503	1,074	3,172	2,327	579	1,097	3,731	2,172	1,047	1,249



V. According to the census, the inhabited houses in the whole kingdom amounted to 4,469,560, divided into 6,872,985 apartments or suites of rooms; of the latter, 6,135,327 were occupied and 737,658 were unoccupied. Each dwelling (apartment) was occupied by a mean of 4.64 individuals. Although the number of families was 6,240,874, not all had a dwelling (apartment) to themselves, but 105,547 occupied the place in common with others.

The occupied dwellings (apartments) were divided into 17,246,169 rooms. Of these, 37,203 were subterranean, and were occupied by 101,457 persons; 3,185,658 were on the ground floor, and were occupied by 7,233,064 persons; 100,662 were in the attic, and were occupied by 183,270 persons.

The subterranean dwellings were found in the greatest number in Abruzzo, in Basilicata, in Apulia, and in the Roman Campania, where many families have their miserable abode in caves dug out of the tufa or rock. In the rest of the kingdom this kind of dwelling is almost unknown, except in some large cities in which cellars are occupied as habitations.

Houses of one story are frequent in Basilicata, in Apulia, in Calabria, in Sicily, and in Sardinia, where the number of families is almost equal to that of the houses; indeed, most of them consist of only one story.

The dwellings of more than one story are numerous, principally in Piedmont, Lombardy, Venetia, Emilia, and in Tuscany, where the rural dwellings are better constructed; whilst in Southern Italy the construction of the houses outside of the larger centers is limited ordinarily to the ground floor.

In the departments to the north of Rome, the number of rooms in proportion to the population is larger than the mean for the whole kingdom; and in Liguria and Tuscany there are almost as many rooms as there are persons.

VI. Generally, 10 rooms are occupied by 16 persons in the large centers of the communes, and by 17 in the country. Limiting the examination solely to the rooms in the attic, 10 rooms are occupied by 18 persons. In houses of one story, the same number of rooms serve 23 persons; and in subterranean dwellings the same number of rooms is occupied by 28 persons.

As a general rule it can not, therefore, be said that the habitations of poor families are spacious; only 2,836 communes lament that the dwellings are not sufficiently healthy and spacious, whilst 5,102 others believe that they are sufficient for the needs of the population; and 311 give no response.

VII. In harmony with this information concerning the hygienic condition of the dwellings are some data concerning the condition of the court yards. In fact 2,411 communes declare that the courts in the interior of the houses are generally too narrow and are not kept sufficiently clean; 3,617 communes believe that there is no reason to complain in this regard; and 2,221 give no information, or say that the houses have no courts.

VIII. Two thousand one hundred and ninety-seven communes declare that the greater part of the dwellings are furnished with latrines; in 3,976, these are found only in the habitations of the well-to-do families; in 1,876, it may be said that they are entirely wanting, and the excrement is deposited in holes, practically uncovered, which are dug in the proximity of the dwellings, or it is thrown from the windows into the courts, or into the public streets, or into the spaces between the houses, or directly into the sea, or into some water-course near the dwelling; finally, 200 communes furnish no information in this regard.

There are 157 communes which declare that the excrement is generally thrown from the window into the street below, whence it is gradually dispersed by the rain and by the winds, or devoured by pigs; 52 communes of Calabria, 46 of the province of Rome, 19 of Abruzzo, 16 of Campania, 13 of Sicily, and a very few others in Southern and Central Italy, are found in this sad condition. There are besides 149 communes, more especially 78 in Piedmont, 17 in Abruzzo, 12 in Liguria, 12 in Venetia, and 8 in Campania, in which there do not exist any latrines, and the excrement, for the most part, is deposited in the stables (which often form the ground story of the house), where it is intermingled with the manure.

IX. For the removal of this refuse material in the populous centers, 100 communes say that they make use of the inodorous pneumatic apparatus; in 2,217, they employ for this purpose imperfectly closed recipients, cess-pits, casks, etc., which are emptied with buckets; in 126 communes the removal of this material is left entirely to the winds and the rain; and 30 communes, of which there are 17 in Calabria, say that this material serves as food for the pigs wandering in the streets; 5,806 other communes leave this question unanswered.

X. This material, in 7,208 communes, is utilized in whole or in part, for agricultural purposes; in 1,041 it is entirely lost.

The waste water in 4,842 communes, for the most part, goes into the latrines or into the sewers, and in 1,277 it is turned directly upon the street or into inner courts; the other 5,131 communes do not answer this question.

XI. Finally, there are 1,483 communes which say that in some of the houses, especially in those of the rural districts somewhat distant from the towns, the fire-places have no chimneys for the escape of smoke, and that the latter spreads throughout the whole room, and escapes by the door, or by the window, or by a hole made in the roof; in 887 communes this condition of things is, in fact, exceptional; but in 596 others, that is in 270 of Sardinia, in 151 of Calabria, in 69 of Sicily, 34 of Liguria, 19 of Lombardy, 18 of Campania, and 35 scattered throughout the rest of the kingdom, the dwellings unprovided with chimneys for the escape of the smoke are quite numerous.

The following table shows the hygienic condition of the dwellings throughout the kingdom for each department:

Departments.	Number of communes which have the houses—				Communes in which the excrement is deposited in the stables.	Communes in which the excrement is thrown into the street.	Communes in which the removal of the excrement is accomplished—				Communes in which the excrement is utilized for manure.	Communes in which the water is discharged—			Communes in which many houses have no chimneys.
	Usually furnished with latrines.	In part without latrines.	Almost all without latrines.	Furnished no information.			By the inodorous system.	By barrels, buckets, etc.	In a manner not specified.	By the rain, or devoured by the pigs.		Into the sewers or into the latrines.	Into the street	Place not specified.	
Piedmont.....	652	534	264	36	78	.....	16	381	1,089	.....	86	257	357	872	102
Liguria.....	75	107	104	16	12	.....	5	127	170	.....	18	92	40	170	99
Lombardy.....	686	1,008	157	45	.....	1	48	384	1,463	1	81	439	190	1,267	76
Venetia.....	159	361	258	11	12	1	9	282	496	2	69	164	122	503	109
Emilia.....	75	159	69	19	2	2	11	95	214	2	23	189	31	102	7
Umbria.....	19	100	33	.....	3	2	1	20	129	2	38	52	29	71	1
Marches.....	69	134	42	3	3	1	3	80	165	.....	16	118	37	93	.....
Tuscany.....	76	180	19	2	6	4	1	108	167	1	5	192	41	44	10
Latium.....	19	142	63	3	2	46	1	35	179	12	97	63	69	95	23
Abbruzzo and Molise.	24	272	156	1	17	19	.....	154	284	15	106	54	66	333	46
Campania.....	155	362	74	21	8	16	.....	200	386	26	111	67	86	459	202
Apulia.....	62	104	69	1	.....	.....	4	141	90	1	20	35	34	167	6
Basilicata.....	2	79	39	3	.....	.....	.....	15	90	18	51	9	10	104	30
Calabria.....	26	197	182	2	2	52	.....	72	292	43	100	35	35	337	290
Sicily.....	60	177	96	22	3	13	1	101	250	3	90	65	87	203	193
Sardinia.....	38	60	251	15	1	.....	.....	22	342	.....	130	11	43	310	289
Total.....	2,197	3,976	1,876	200	149	157	100	2,217	5,806	126	1,041	1,842	1,277	5,130	1,483

## ANIMALS AND STABLES.

I. According to the census made in 1876, the number of horses in the kingdom was upwards of 657,544, and that of mules 293,868. According to the census of 1881, the bovine animals were 4,783,232 in number, and the fowls were 8,596,108; the goats were 2,016,307, and the swine 1,163,916. Classifying them according to districts, and making the proportion per thousand inhabitants, in order to show the districts in which the animals are the most numerous, the figures of the following table are obtained:



Rural districts.	Horses.	Mules.	Donkeys.	Cattle.	Fowls and goats.	Swine.	Per 1,000 inhabitants.					
							Horses.	Mules.	Donkeys.	Cattle.	Fowls and goats.	Swine.
Piedmont.....	33,911	24,176	29,626	843,053	506,827	85,301	11	8	8	275	165	28
Lombardy.....	93,364	13,953	39,664	840,324	257,865	125,845	25	4	11	228	70	34
Venetia.....	76,215	8,594	37,822	739,925	446,784	117,671	27	3	13	263	159	42
Liguria.....	5,278	11,709	14,706	116,825	270,898	14,913	5	11	14	110	255	14
Emilia.....	40,056	4,568	46,776	659,066	475,314	142,360	22	2	21	202	218	65
Marches and Umbria	24,718	6,852	50,766	291,646	1,224,336	194,559	16	4	33	193	810	129
Tuscany.....	53,074	5,070	40,648	313,350	1,081,276	114,923	26	2	20	154	530	56
Latium.....	44,326	9,772	35,598	96,587	809,222	33,258	49	10	39	107	896	37
Meridionale Adriatic	80,183	56,146	121,286	293,815	1,909,222	69,646	27	19	41	70	657	24
Meridionale Mediterra-	54,465	39,829	142,671	273,617	1,875,238	168,319	12	8	30	58	401	36
Sicily.....	46,566	112,115	82,702	125,556	649,051	36,769	15	38	28	53	222	13
Sardinia.....	64,801	199	31,981	279,438	1,106,382	60,347	95	0.30	47	410	1,623	89
Quadrupeds belonging to the court, government, and army officers.....	31,587	885										
Total.....	657,544	293,868	674,246	4,783,232	10,612,415	1,163,916	23	10	23	178	373	41

II. In the whole kingdom, 236 communes declares that the animals live all the year out of doors; 2,991 say that they live partly out of doors and partly in the stables, and 5,022 possess stabling sufficient for all their animals.

III. In 4,439 communes the inhabitants have the custom of spending the winter evenings in the stables (which usually constitute the ground story of the dwelling), and in 2,122 communes they not only pass their evenings there, but also the nights, the entire family sleeping there among the animals, therefore in a damp, mephitic, and bad air, to the great detriment of their health.

But these habits vary markedly in the different districts, as the following table shows:

Departments.	Number of communes in which—				
	All the animals live out of doors.	The animals live partly out of doors and partly in stables.	The animals are all provided with stables.	The families usually—	
				Pass the winter evenings in the stables.	Sleep in stables and live with the domestic animals.
Piedmont.....		146	1,340	1,227	280
Liguria.....		9	293	8	
Lombardy.....		26	1,800	1,806	47
Venetia.....		81	708	591	14
Emilia.....		12	310	268	8
Umbria.....		57	95	9	3
Marches.....		13	235	117	24
Tuscany.....	3	33	241	24	
Latium.....	1	236		4	2
Abruzzo and Molise.....	5	448		93	57
Campania.....	1	611		79	130
Apulia.....		236		76	69
Basilicata.....		123		13	75
Calabria.....	17	390		31	131
Sicily.....	19	336		77	182
Sardinia.....	190	174		16	100
Total.....	236	2,991	5,022	4,439	1,122

#### SUMMARY.

The origin of the first outbreak of the recent epidemic of cholera in Italy during 1884 has naturally been far less difficult to trace than was that of the introduction of the disease either into Egypt or into France. It appears to be very certain that some of the vast numbers of Italians returning homeward from the infected cities of Toulon and Marseilles, into the north-

ern part of Italy, by land and by sea, brought with them to the neighborhood of Genoa and to Spezia the seeds of cholera, which took root and spread during that year to some extent in various directions throughout the northern part of that kingdom. It has been well ascertained, also, that the quite severe epidemic in Naples the same year owed its origin to direct importation by sea from the southern coast of France, through returning Italian sailors and their effects. It has likewise been quite well determined that the outbreak of the epidemic in 1885 at Palermo and its environs was due to the smuggling of dirty clothing between Marseilles and the former city.

Whether the recurrence of cholera in 1885, 1886, and 1887 in many parts of Italy was a real recrudescence from the slumbering seeds, as it were, of the epidemic of the preceding year, kept in a state of slight activity by occasional transmission from case to case during the mild winter in that climate, or was due, at least in some instances, to new importations directly from India, can not now be clearly shown. Some Italian physicians of distinction have held that the cholera of the latter years along the Adriatic coast and inland for some distance, was in fact a development of the re-imported seeds of the disease fresh from India. This has been the prevalent opinion regarding the appearance of cholera in 1886 at Brindisi, the Adriatic port where the Anglo-Indian Peninsular and Oriental mail steamers take aboard their eastward and discharge their westward mails, as well as the greater number of their passengers, with their personal effects. These westward bound steamers, after touching at Brindisi, proceed northward as far as Venice, the European end of their route, where the bulk of their cargo and the majority of their crew, besides their second and third class passengers, are landed.

As to the hygienic conditions, mode of life, and peculiar customs usually prevailing in Italy, sufficient has been related above to show that the whole kingdom was in a most favorable state for the spread of Asiatic cholera among that people. The only occasion for surprise is that the epidemic there was not far more extensive and destructive. There is strong reason to believe that the limitation of the epidemic of 1884 was solely due to the natural state of alarm and consequent adoption and fairly effective enforcement of combative measures. The investigations of Maragliano introduced in this section and in chapter VII of this report very clearly show that wise measures of prevention, promptly adopted and vigorously enforced, are capable of at least markedly retarding the march of cholera, even among a people whose grossly unhygienic customs and habits afford the most favorable opportunities for the wide dissemination of all sorts of infectious diseases.

Before leaving the consideration of cholera in Italy, I feel that a word should be said of the history already related of the very sudden outbreak and short course of the epidemic of Genoa in 1884. This epidemic, in my opinion, constitutes one of the most striking examples on record of a rapid and wide explosion of cholera in a large city, affecting the well-to-do and the wealthy even more severely than the poor and squalid, through infection of the water supply at its source, and at the same time of the prompt arrest of the epidemic by cutting off the contaminated water.

The Kingdom of Italy furnishes another most instructive experience relating to the quality of the public water supply and the ravages of Asiatic cholera in a large city.

I have already spoken of the liability of a large part of the public water supply in Naples at the time of the epidemic of 1884 to become grossly polluted. The severe lesson of that year opened the eyes of the municipality and of the Government to the necessity of improvement. At a great cost, borne mainly by the General Government, abundance of pure water, brought from a mountain stream known as the Serino, 80 miles distant, was introduced into this city and distributed in May, 1885. In the summer of this year cholera made considerable ravages in neighboring towns, which are practically suburbs of Naples, but not supplied with the Neapolitan water, whilst the city itself did not experience an epidemic; and the same was the case in the following years, notwithstanding the repeated importation of the disease by numerous refugees from the stricken districts of southern Italy and of Sicily. But during 1887 the Serino aqueduct broke and necessitated a return to the former bad water-supply, followed in a very few days by a small epidemic outbreak of cholera, which was soon ended, fortunately, by the turning on again of the Serino water after the repairs had been made.



## ILLUSTRATIONS Nos. 4, 5.

Two maps of Spain in which the relative cholera mortality in the kingdom of Spain, during the epidemics of 1865 and 1885, is graphically represented. For these maps I am indebted to the interest in the subject, and the courtesy of Mr. Ferguson, an English engineer residing in Madrid. The figures marked within the outline of the various provinces indicate the mortality per thousand of inhabitants. The varied shades and tints of color express comparatively, but less approximately, the extent of mortality.

A comparison of these maps will show at a glance that whilst the cholera visitation of 1885 was far more severe than that of 1865, the greatest prevalence of the disease in each instance was mainly in the provinces bordering upon or near to the Mediterranean. In the epidemic of 1865 the greatest mortality occurred in the province of Valencia, whilst in that of 1885 the greatest mortality was in the provinces of Saragossa, Granada, and Valencia. It is to be remarked that these are the provinces in Spain in which artificial irrigation is most extensive.



No. 4.  
 Showing Extent and Mortality of the  
**CHOLERA EPIDEMIC**  
 by PROVINCES  
 in  
**SPAIN**  
 1865







No. 5.  
Showing Extent and Mortality of the  
**CHOLERA EPIDEMIC**  
by PROVINCES  
in  
SPAIN  
1885





## SECTION 4.

## CHOLERA IN SPAIN.

Cholera was temporarily planted in Spain during the summer of 1884, in a few places in the Province of Alicante, as the table below indicates, but it did not become epidemic in that country until the spring of the following year. After the introduction in 1884, and the limited spread of the disease during the summer and autumn of that year, it slumbered through the mild winter of that climate in the neighborhood of Gandia, a town in the lower maritime portion of the Province of Valencia, lying to the north of Alicante. There were, from time to time, in that neighborhood, during the winter of 1884-'85, a few scattered "suspicious cases," which were evidently cholera. At the opening of the spring of 1885, agricultural laborers who wintered at and around Gandia carried the infection to Játiva, there is strong reason to believe, where the epidemic of 1885 first suddenly exploded.

*Cholera in the province of Alicante during 1884.*

Localities.	Date of invasion.	Number of attacks.	Number of deaths.
Alicante .....	Aug. 22	9	6
Elche .....	Sept. 2	110	61
Novelda .....	Sept. 2	77	60
Monfort .....	Sept. 3	123	69
Villena .....	Sept. 3	4	2
Villafranqueza .....	Sept. 18	1	1
Vergel .....	Dec. 8	4	.....

The origin of the disease during 1884, in Spain, has not been precisely established, but it is pretty certain that it was brought to the shores of the Province of Alicante by a family of Spaniards returning from Marseilles by a circuitous route. This family sailed from the latter city to the French Province of Oran, on the northern coast of Africa, where they procured transport for themselves and their personal effects to a maritime village in the vicinity of Alicante. They successfully evaded the surveillance of the Spanish quarantine officials and effected an entrance into Spain, carrying with them the seeds of the epidemic.

Accounts of the origin of the first appearance of cholera in Spain during 1884 differ, however. That of Rapschewski, commissioned by the Russian Government, published in *Vratch*, 1886, is essentially as follows, concerning this matter:

The relation between the epidemic of 1884 in Marseilles and Toulon and the Spanish epidemic of 1885 is clear. In a few places on the coast of the Mediterranean which have regular intercourse with the infected French ports cholera was introduced and followed a slightly epidemic course, with a few cases up to the winter of 1884 and 1885 (in Beniopa, Novelda, Elche, Monoforte) and in one or two localities isolated cases ran through the winter.

In April, 1885, the epidemic began first in Játiva and Alcira. In the first it was introduced by some civil guards from Beniopa, and in the second by a family from Novelda. The southern part of the province of Valencia is very low and very watery, and has many rice plantations. In the spring many laborers living under very bad hygienic conditions were congregated together there; in the middle of May they dispersed again. If among these laborers there occurred suspicious cases the author does not know; nevertheless, the disease broke out between the 28th of March and the 1st of May in many neighboring localities, and about the time when the laborers dispersed in the middle of May the disease appeared in quite distant places, for example in Madrid.

With respect to the manner of the spread of cholera throughout Spain, Rapschewski quite believes in "the drinking-water theory." He is strongly convinced that those large cities,



having a supply of good drinking water conducted through closed pipes, before the epidemic outbreak of cholera, have been safe from invasion. To that category belong Madrid, Barcelona, and Seville. On the contrary, all the severely attacked cities were supplied with very badly contaminated drinking water, such as Valencia, Granada, and Aranjuez.

*General résumé by provinces of official cholera statistics in Spain during 1885.*

[As obtained from the Ministry of the Interior.]

Provinces invaded.	Number of judicial districts invaded.	Number of towns invaded.	Population, according to the census, exposed to the epidemic in each province.	General total.		Total number of days of the epidemic.	Mortality percentages of—	
				Attacks.	Deaths.		The population.	The attacks.
Alava .....	3	18	17,112	859	325	116	1.90	37.83
Albacete .....	8	39	130,921	8,236	3,244	139	2.48	39.39
Alicante .....	14	75	311,425	13,977	5,645	142	1.81	40.39
Almería .....	9	51	242,213	9,660	2,566	92	1.06	26.56
Ávila .....	4	5	48,770	509	159	76	0.85	31.24
Badajoz .....	3	4	35,240	950	558	89	1.58	58.74
Barcelona .....	15	68	541,211	6,302	2,915	118	0.54	46.26
Burgos .....	10	35	63,529	2,310	786	122	1.24	34.03
Cáceres .....	2	2	2,178	147	57	63	2.62	38.77
Cádiz* .....	5	7	130,631	2,232	984	173	0.75	44.09
Castellón .....	9	80	214,686	16,753	6,436	118	3.00	38.42
Ciudad Real .....	6	15	92,879	3,727	1,688	96	1.80	44.75
Córdoba .....	8	13	138,369	3,787	1,318	96	0.95	34.80
Cuenca .....	8	123	137,649	10,003	3,459	133	2.51	34.58
Gerona .....	6	38	73,649	2,194	652	94	0.89	29.72
Granada .....	15	132	364,568	24,736	10,285	132	2.82	41.58
Guadalajara .....	6	33	28,496	2,944	777	93	2.73	26.39
Guipúzcoa .....	4	13	59,004	304	158	123	0.27	51.97
Huelva .....	5	11	46,336	462	231	123	0.50	50.00
Huesca .....	5	49	63,387	5,762	1,273	144	1.95	21.46
Jaén .....	11	35	207,024	5,039	2,599	115	1.26	51.58
Leon .....	1	3	7,981	111	48	47	0.60	43.24
Lérida .....	6	54	83,330	3,441	1,399	112	1.45	35.13
Logroño .....	9	33	53,944	5,046	1,220	100	2.26	24.18
Lugo .....	3	4	31,144	16	16	78	0.05	100.00
Madrid .....	16	44	477,712	8,584	3,559	146	0.75	41.46
Malaga* .....	12	28	141,722	5,037	1,702	132	1.20	33.79
Murcia .....	10	36	420,229	17,749	7,376	126	1.76	41.66
Navarra .....	5	81	161,626	12,895	3,161	150	1.96	24.51
Orense .....	1	2	9,741	94	39	43	0.40	41.49
Oviedo* .....	4	6	72,352	64	38	104	0.05	59.38
Palencia .....	4	33	42,578	3,587	818	98	1.92	22.80
Pontevedra .....	1	1	4,181	16	9	22	0.22	56.25
Salamanca* .....	7	40	40,102	1,288	476	172	1.19	36.96
Santander .....	6	25	97,538	921	458	114	0.47	49.73
Segovia .....	5	63	50,917	2,403	803	124	1.58	33.42
Sevilla .....	7	8	167,201	247	101	145	0.06	40.89
Soria .....	5	57	36,654	3,079	1,019	114	2.78	33.09
Tarragona .....	8	61	196,448	8,740	2,536	116	1.29	29.02
Teruel .....	10	161	171,312	21,909	6,960	121	4.06	31.77
Toledo .....	12	73	170,857	10,308	3,972	133	2.32	38.53
Valencia .....	21	219	630,321	45,515	21,612	246	3.43	47.48
Valladolid .....	11	101	157,019	7,578	2,603	94	4.66	34.35
Vizcaya .....	4	16	33,626	635	274	61	0.81	43.15
Zamora .....	5	30	49,418	3,587	764	119	1.55	21.30
Zaragoza .....	13	222	348,361	54,943	12,788	142	3.67	23.29
Total .....	342	2,247	6,575,641	338,685	119,620	330	1.82	35.32
Population unattacked ..	159	7,067	10,396,839					

\*The epidemic entirely ceased in the province of Cadiz the 22d of March; in that of Malaga the 19th of January; in that of Oviedo the 31st of January; and on the 17th of the said month in that of Salamanca, during 1886. Not a single case has been registered in the whole Peninsula since the last date.

*Résumé of the course of cholera in the thirty-five military and civic-military hospitals during the cholera epidemic in the year 1885.*

[Obtained from the office of the director-general of military hygiene.]

Year.	Attacks.	Deaths.	Cures.	Percentage of deaths to number treated.
1885....	1,432	377	1,055	26.32.

#### CONSULAR REPORTS RELATING TO CHOLERA IN SPAIN AND GIBRALTAR.

In a dispatch from the consul at Carthagena, Spain, dated June 16, 1885, the information is given that the capital of the province of Murcia and several small inland villages in the consular district are invaded with cholera. In Carthagena and its port every precaution is taken to prevent the disease from reaching us, and at this very moment a most rigorous sanitary cordon has been established for the purpose of isolating this town and port. Up to this time there have been no suspicious cases here.

By a dispatch from the consulate at Barcelona, Spain, dated August 4, 1885, the State Department was advised as follows:

Since the 26th of July rumors were current that a few cases of a disease resembling cholera had appeared, but medical men, also the sanitary board, denied it. Since the outbreak of the terrible disease in Valencia, and other southern districts, a great many persons fled from the infected cities and took refuge in this city, so that at the present date Barcelona is sheltering 20,000 runaways. This morning I was privately informed by a member of the health board that 15 cases and 16 deaths had been reported to the board during the past twenty-four hours, and that the governor peremptorily refused to declare the existence of cholera. The latter official's reasons I understood to be that the Barcelona district, being entirely industrial and manufacturing, with more than 150,000 workmen employed, on a declaration of cholera all factories and workshops would be closed and at once without work. Many of these men were well known to entertain republican and anarchistic ideas, who would take advantage to foment a general rising for political ends.

By a dispatch from the same consulate, dated August 18, 1885, the Department was informed of the extinction of cholera in the port.

In a dispatch from Cadiz, Spain, dated December 14, 1885, is copied the following letter from the consular agency at Huelva, of the date of December 12, same year:

In reply to your favor of 9th instant respecting cholera in this town, I beg to say that although it has not been officially declared (the authorities doing everything in their power to keep it quiet), I am informed by the English doctor here that it is a fact that cholera exists, there having been since it broke out about a fortnight ago 8 cases and 5 deaths. The houses where the cholera cases have taken place have been all disinfected, and everything is being done to prevent the spread of the epidemic. I would have informed you of this earlier, but I was unable to obtain any reliable information on the subject, there being such conflict of opinion.

Under date of December 19, 1885, the consul at Malaga, Spain, reports at Marbella the appearance of certain suspicious cases of colic in that town, and in a dispatch of December 24, 1885, the announcement of cholera in Marbella is made.

The consul at Gibraltar, on the 31st of December, 1885, stated: Although not yet officially declared by the Spanish authorities, it would seem that the neighboring Spanish town of Algeciras, lying west of Gibraltar, is being visited by cases of cholera (morbus), some of which have already proved fatal.

Cases of cholera have also been occurring at the Spanish town of Marbella, some 30 miles to the eastward of Gibraltar, which have induced the board of health here to consider that port foul.

I have much pleasure in being able to state that, so far, good health is enjoyed in this town and garrison.



The consul at Gibraltar, dated January 6, 1886, forwarded the following dispatch: With reference to my communication of the 31st ultimo, in which I announced the appearance of cholera morbus at the neighboring Spanish town of Algeciras, which is but 5 miles distant from Gibraltar by water and 10 by land, I have now to inform the Department that the number of cholera-morbus cases have lately increased to 30. The Gibraltar board of health decided on the 2d instant to suspend all communication with Algeciras by sea, but the land communication remaining open the circumstance is causing new difficulties with other foreign sea-ports so as to render it probable that quarantine restrictions will at once be established against arrivals from Gibraltar; in fact the board of health of Tangiers, in Morocco, has since yesterday decided to turn off all arrivals coming from this port.

So far, the British authorities show no desire to close the land communication with Spain; therefore, so long as cholera-morbus cases should prevail in this immediate neighborhood I apprehend the navigation and commerce of Gibraltar will suffer and experience great depression.

To refuse communication with Algeciras by sea and not by land does not seem logical; though the British authorities may perhaps have their own reasons for giving a deaf ear to the entreaties of the majority of the commercial community here who would prefer to see a sanitary cordon established against the Spanish lines than to have this port subjected abroad to quarantine restrictions.

In a dispatch from the consul at Gibraltar of January 6, 1886, it is stated: I am happy to be able to report for the information of the Department that no further cases of cholera morbus have occurred at the neighboring Spanish town of Algeciras since the 17th instant, but some cases of this epidemic have lately appeared at Tarifa, which is about 24 miles distant from Gibraltar by land.

The communication by land between Tarifa and Gibraltar being so much less frequent than with the other surrounding Spanish towns, with the sanitary formalities still existing in full force here against all arrivals by land from infected towns in Spain, no uneasiness now prevails amongst the inhabitants of Gibraltar, which fortress continues to enjoy excellent health.

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#### *HYGIENE AND DOMESTIC LIFE IN SPAIN.*

##### *WATER SUPPLY.*

The hygienic surroundings and the domestic habits of the population of Spain perhaps deserve particular mention. The portions of Spain which have been always most severely ravaged by cholera epidemics, and the recent one has been no exception, are regions where artificial irrigation is most extensive—such as the provinces of Valencia, Saragossa, and Granada. In these regions, which are wonderfully fertile, the system of artificial irrigation is, perhaps, the most extensive and perfect in the world. This system was introduced by the industry of the Moors, and by means of it this industrious and intelligent people soon converted these naturally barren regions into beautiful and fertile gardens, literally causing the desert to blossom with the rose. At the time of their expulsion from Spain the whole of the country occupied by them was found to be abundantly watered by this artificial means. In by far the greater part of that territory the Spaniards have permitted that system of irrigation to fall into decay, and as a consequence many portions of Spain which under the dominion of the Moors were highly productive, have been allowed to revert to their original barrenness; but in a few provinces such as Valencia, Granada, Saragossa, Murcia, and some others, the system still exists in varying degrees of perfection. The main irrigation canals and the means of raising and distributing the water are in many cases the identical ones abandoned by the Moors on their departure from the country.

Of all the irrigated provinces, that of Valencia is most abundantly supplied with water. This province occupies a broad, level plain included between the distant ranges of mountains on the west and the Mediterranean on the east. Several large rivers wend their tortuous way from the base of the mountains to the sea, the Júcar and the Turia being the largest. Of

these two the Turia was originally the larger. The city of Valencia, the capital of the province and the old capital also of the ancient kingdom of Valencia of the Cid, is located upon the right bank of the Turia about 3 miles above its mouth. The river at this point is perhaps three-quarters of a mile across, but its sandy bed is almost bare throughout its whole width, and the stream can be forded at almost any point. Nearly the whole of the immense volume of water which flows in the mountainous portion of this river is diverted into irrigation canals which constantly tap it along its course from the mountains to the sea. In fact, all of the rivers and streams traversing the districts where irrigation is practiced give the greater portion of their water to innumerable main canals, which finally conduct it to the small canals and water trenches by which it is finally distributed among the fields. There is scarcely a village located upon the broad plains, which constitute nearly the whole province of Valencia, which is not upon the course of some one of these main canals. The same relation of the villages to the irrigation canals may also be said to exist in all the other provinces where irrigation is extensive, and those villages located along the course of natural streams also are frequently traversed by one or more canals.

The water of these canals not only is used for the purposes of agriculture, but also supplies the inhabitants for drinking and other domestic purposes. It is the universal practice in the villages located upon them to use them as public lavatories, the clothing being seldom washed within the dwellings. To one who passes along the course of these artificial streams through the village, it is a constant sight to notice the banks lined with little stone slabs at the level of the water, upon which women are seated in the act of washing their household linen; and while this is being done other women will come down to the same stream with water jars upon their heads for the purpose of drawing water for household uses, drinking included. As in Italy and France, these irrigation canals during their passage through the villages often serve as public sewers.

In some cities there is a certain supply of drinking water also from wells, either public or private, and what has been already said of the construction and location of the wells in the city of Palermo may be applied to the wells existing in the Spanish towns. The manners and customs of the people of Spain in many respects differ greatly in the different provinces. In some sections, particularly in those last occupied by the Moors, namely, the ancient kingdom of Murcia, and that portion known as Andalusia, a custom widely prevails of storing drinking water during the winter and early spring, thus providing for a supply of excellent and limpid water, when it is well preserved, which is intended to last during the rest of the year. In some places each house is supplied with quite a number of enormous terra-cotta jars. These jars are frequently glazed at their inner surface, but they are often porous. The jars, when they are above ground, are usually ranged around the sides of the interior court; but in the dwellings of the easy classes, and especially of the rich, in order to save the space which these great jars occupy when above ground, they are sunken beneath the earth, the top of the neck of the jar usually being just below the level of the flags forming the floor. The latter location of the water jars is very frequently met with in the cities and large towns of the provinces of Seville and of Cadiz. In these two provinces the interior court of the houses of the rich is most beautifully decorated, and is the favorite place of resort, during the afternoon and evening, of the members of the household; a fountain plays in the center, almost hidden by a wealth of tropical plants, and the court is roofed in by canvas awnings in the summer and by glass in the winter. The water jars are usually found beneath the floor of this court. They are frequently supplied with water by pipes which collect the rain from the roof of the dwelling. The *cloaca negra*, or sink, which receives the household sewage is not far distant, being usually located beneath the floor of the main entrance hall from the street.

I have spoken of the custom of filling these water jars in the winter and spring. This, of course, does not apply to those which are filled by the rain-water from the roof. The custom of storing the water in the winter and spring for use during the rest of the year is most prevalent in the province of Murcia. In the city of Murcia, for instance, which is located upon both sides of the river Segura, it is the custom of the inhabitants to draw the water from the



river during the cold season for the purpose of filling their jars. The water in this river is usually very muddy, and of a reddish-yellow color. When allowed to stand in these jars, however, it becomes clear as crystal by the deposit of the solid particles held in suspension upon the bottom and sides of the jar, forming a thick sediment.

When these water jars are above ground, the water is comparatively free from the possibility of serious contamination after it is stored in them; but when they are sunk beneath the ground, especially when they are located within a few feet of the *cloaca negra*, the danger of contamination of their contents will be readily appreciated. The construction of the *cloaca negra* is usually identical with that of the *pozzo nero* of Italy; that is, without the use of cement, and of a bottom without pavement of any kind. With a *cloaca negra* full to the brim of semi-solid and fluid material and a sunken water jar with an unglazed surface, and with walls consisting of a somewhat porous material, half empty of water, separated from the *cloaca negra* by only a few feet of porous soil, it is to be expected that the drinking water stored in these sunken jars may become more or less contaminated by filtration of the fluid excrementitious discharges of the household. Further than this, the mouth of the jar is in communication with the court. It is usually more or less imperfectly closed by means of a stone slab which forms a part of the pavement of the court, and it is evident that in cleaning the floor of the court a certain amount of the foul water may thus find its way into the water jar. In some of those houses where the sunken water jar is filled by rain-water from the roof, there is a provision made for the overflow, consisting of a pipe near the top of the jar, which leads sometimes directly into the gutter of the street, but more frequently into the *cloaca negra*, when the latter exists. So that here again is an opportunity for the contamination of the drinking water of the household, by the overflow of the sink back into the water jar. This, unfortunately, has not infrequently been known to happen. In fact, even in the old Spanish town of Gibraltar, where the hygienic regulations, from the fact of its being a garrison town under English government, should be of the best, this private supply of drinking water by means of sunken water jars exists to a certain extent. And certain mysterious outbreaks of typhoid fever in residences apparently perfectly constructed and provided with the most modern arrangements for drainage have been, after careful investigation, traced to the contamination of the rain-water in the sunken water jar by reason of the backward flow of the contents of an over-full sink through a pipe leading from the water jar to the sink originally intended, of course, as a vent for the surplus of rain-water in the water jar, a connection of which, up to the time of the investigation, the inhabitants of the house had no knowledge. These large water jars are often used for years; in fact, where their location is beneath the earth, they are usually placed there at the time of the construction of the house, and it is reasonable to believe that they may be quite as frequently cracked in the course of time as are the walls of the houses themselves. Here again is a provision for the contamination of the drinking water by means of the introduction of organic or other noxious material from the surrounding soil.

As further evidence of the common want of hygiene in Spain I introduce a portion of the report on cholera in Spain, 1885, by W. T. Van Vredenburgh, M. D., of New York.

Edward H. Strobel, chargé d'affaires *ad interim* at Madrid, transmits, under date October 2nd, 1885, the following report on cholera in Spain:

I have spent the four months of June, July, August, and September in Spain for the purpose of studying the cholera, and I find all of these predisposing causes, especially those of environment, existing to such a marked degree that my surprise is, not that this epidemic of cholera has been so severe, but that it has not been much worse.

When one considers the entire absence of knowledge existing in regard to the simplest hygienic laws and sanitary conditions, necessary to health among the people of all classes, and the limited knowledge on these subjects among those who should instruct the people, it can only be ascribed to a happy combination of circumstances that all, instead of a part, of this peninsula has not been ravished by the cholera.

Wherever excremental pollution is rife, if once the disease obtains a footing it is almost certain to assume epidemic proportions, for the "unknown quantity," the *x*, of the cholera is

closely associated with excremental pollution. Three conditions described as being practically the causes of cholera in this country, namely, "excrement-polluted earth, excrement-polluted air, and excrement-polluted water," are manifestly in full and active operation.

Ordinary rules and customs that govern people in other countries are strangely absent in this land. In most villages, towns, and cities the main streets, not alone those that are retired, but the more public as well, are made the receptacles for this description of refuse at all times, and at Aranjuez during the epidemic of cholera there last July, in the houses where those ill of the disease had families to nurse them and were allowed to remain, the cholera "dejecta," which should be so utterly and carefully disinfected and disposed of, were in some instances thrown out into the streets and into the back yards; the sheets stained by the patients were exposed for days spread out over the gardens and lawns, and the wind freely distributed far and wide the poison that had come from the bodies of the patients.

Sanitary precautions there were utterly disregarded, and knowledge of the terrible consequences that must accrue from this filthy carelessness seemed altogether wanting. This is only an isolated case of the existing ignorance of the people of the danger which was sure to result from carelessness in disposing of cholera dejecta. Disinfection, when practiced, is intrusted to utterly incompetent persons, and must be entirely inefficacious.

In Toledo, in two instances, the bedding and furniture of patients who had died of cholera were bought by second-hand dealers, put into their shops, and offered for sale, and these two places subsequently became new foci from which the cholera spread. In all of the smaller towns and cities, and most of the larger ones, not excepting the capital, the condition of the sewers and system of drainage has been a subject that no one has thought worthy of investigation; and in one large city, capital of a province, when several physicians, sent down into Spain by their respective Governments to study the disease, asked the civil authorities if they had any plan or chart of the main sewers and drains of the city, the authorities hardly knew what the physicians meant, and did not know what need there was for any such information.

During the occupation of Spain by the Moors, that primitively cleanly people thought so highly of personal purity and the obvious advantages of plenty of pure, good water—the use of which, indeed, formed part of their religion—that they built everywhere in their dominion aqueducts, reservoirs, fountains, drains, and sewers, and used the natural advantages of the soil, when existing, to turn the springs and water-courses to their use and advantage, and as far as one can judge from what is left of their architectural monuments they had a most perfect system of water supply, and equally perfect system of drainage and sewerage.

In most of the towns and cities of Spain the inhabitants depend solely on sewers and drains built during the Moorish occupation. I have visited many small towns where the only drain is the remnant of a huge brick sewer, the upper part being entirely open and exposed; and through this sluggishly ran a dirty stream into which the inhabitants threw all of their refuse. These open canals, as they might be called, usually run through the main streets, and the people living in the immediate vicinity can hardly do otherwise than breathe the emanations arising from these foul streams under the hot summer sun of Spain.

There is no drainage, as the subject is usually understood, in most of the small towns and villages. Many of the houses are built directly on the ground, and the first story (usually the only one) has no other floor than the earth.

Most of the houses are very old; they are crowded together in dark, narrow, tortuous, dirty streets, with small, filthy back-yards, in which are sometimes the wells, though just as often these are sunken in the "earth" floors of the houses. In these small towns and villages there are no cess-pools nor closets, as the streets are used for such purposes and are made receptacles for every sort of refuse.

In larger cities one sees in the vestibule of a handsome house a large circular stone sunk in the floor, and on inquiry one finds that this stone is the cover of the common cess-pool of the house, placed there for some reason best known to the people themselves.

When modern sewers do exist, as in Madrid, they are constructed of a thin, porous brick sunk in a dry, porous soil, eager to drink up any liquid which it can obtain, and the porosity



of the brick allows the liquid contents to escape into the surrounding subsoil. Neither are the cess-pools water-tight; if they are constructed of mason-work, which is not often the case, they are made of the same porous brick, and they contaminate the surrounding soil, for the dangers of a cess-pool depend almost entirely on the tendency of its contents to escape in the surrounding earth and thus obtain access to wells and other sources of water supply.

The water supply of Madrid is, without question, the best in Spain. The Lozoya Canal brings water from a distance of 32 miles. Unfortunately the water-course is not covered throughout, and it might easily be polluted. The Government seemed to recognize this danger, and placed three hundred "guardias civiles" along all the exposed portions of the canal, and these men watch day and night to see that there is no pollution.

The water, however, must approach the city at a somewhat lower level than the porous sewers, and it is quite possible that percolation through the earth may find entrance into it. Such percolation can often be traced to long distances, and there is at least one well-authenticated instance, that furnished by the epidemic at Lausen, near Basle, in 1882. of the poison of typhoid fever reaching a water-course a mile distant from the spot where that poison was originally deposited, and after an amount of filtration through earth which had entirely arrested particles of flour. The custom that prevails in cities of Southern Europe of washing soiled linen in the fountains and streams to which the people go for water for domestic purposes is objectionable and dangerous, especially during a season of cholera, when water polluted in this manner, and as well by sewerage, runs over the land and settles in low-lying districts or empties itself into streams, rivers, or other sources of water supply and becomes a new focus for the development of cholera, as has been plainly demonstrated in the case of the city of Aranjuez, of which mention has already been made.

The topography of Madrid is very favorable for its effective drainage, as all the surrounding and arid plains are on a lower level than the city itself; the sewers fall into these plains, the water forming a course for itself until it is lost in porous soil or joins the river Manzanares. The natural topographical advantages altogether disappear as soon as the sewerage leaves the town. Lying to the south of Madrid is a huge main sewer or stream where nearly all the drainage of Madrid accumulates and forms an open pond. The fall of the sewers in the city is equal to six in a hundred, but here it is hardly one in a thousand; it is so slight that heavy rains cause this fluid to overflow, and it was here, amid the group of houses in the plain of Pennela, that the first case of cholera occurred on the 22d of May last. This semi-stagnant *cloaca* is only a few hundred yards beyond the densely populated poorest quarter of Madrid.

Aranjuez, 30 miles from the capital, is south of Madrid, occupying comparatively low ground, on the angle formed by the junction of the rivers Tagus and Jarama.

The river Manzanares, which carries off a large portion of the sewerage of Madrid, falls into the Jarama about 12 miles from the capital. The first village beyond this point has been exempt from cholera, but this is an argument in favor of the contamination of the Jarama by the Madrid sewerage, for at this village, San Martín de la Vega, there is an excellent supply of spring water, and the inhabitants do not drink from the river.

Immediately beyond, however, at Ciempozuelas and among the clusters of cottages on the banks of the river, where its waters were drunk, cholera wrought havoc.

Leaving the Jarama and traveling in a southerly direction, we reach the banks of the Tagus; here there is no cholera, until at a distance of more than 50 miles from Madrid the Tagus receives the waters of the Jarama, which in its turn has been fed by the sewers of the capital. There the cholera is at once manifested, and ravages the rural population. So far, the evidence seems most conclusive, particularly as the cholera appeared first in this region at Madrid, and the dates of the different outbreaks allow ample time for the infection to travel down those water-courses.

We have here a very clear instance of river pollution and its natural consequences. In the way of poverty, personal dirt, and uncleanness, and overcrowding among the lower poor, there is nothing in Spanish cities which might not be equaled in other countries; but these conditions, when superadded to the notoriously imperfect system of drainage and sewerage that

prevails in Spain, enormously increase its otherwise sufficient powers for evil. Accumulations of filthy and cholera-tainted rags, and the innumerable other sources of filth supply, must all be regarded as important contributors towards maintaining the prevalence and providing for the diffusion of the disease.

A few words about prevention in regard to cholera.

Nearly all lands are agreed that reliance on quarantine alone is insufficient to prevent the introduction of cholera into a previously healthy district, and to limit it after its presence is an established fact.

A wiser plan would be to inspect unostentatiously all new arrivals from a suspected or infected locality, and carefully follow all cases in which there may be even a suspicion of the disease. The best method of limitation is to secure a building in an isolated but healthy situation, to have nurses and doctors ready to proceed to the building where first cases can be strictly isolated; inspection and disinfection daily of all closets, cess-pools, sewers, and drains, and reconstruction when necessary, using non-porous materials, building good, narrow, easily-flushed drains and sewers, and have them flushed with sufficient water at frequent intervals. Organize hospitals, prevent overcrowding in poor-houses and other public institutions, feed the poorer classes well, and look into the condition of their dwellings, closets, and drains frequently and rigorously.

Disinfect houses where disease has settled, removing the sick to special hospital, isolating other inmates for a sufficient time (as is practiced at Gibraltar, where those exposed to disease by the presence of a case in their dwellings are removed to tents outside the city); proper care of patients' bedding, burning contents of, and immerse ticking, etc., in boiling water; filter and boil all water used for drinking and domestic purposes, and above all things cut off an infected water supply and see that water used is plenty and free from contamination.

Confirmatory of the foregoing is the following highly instructive and accurate account of hygienic conditions and water supply in Spain:\*

The epidemic of Asiatic cholera, which has been raging in Spain during the last two years, and which appears even yet to be lurking in some portions of that peninsula, has furnished some interesting data as regards its connection with water supply, to which it would be wise in us to direct our attention, not only from the interesting nature of the facts as such, but also because it is not improbable that ere the disease quits Europe it may visit our own shores.

Broadly speaking, it would appear that in Spain this formidable disease never became truly epidemic or dangerous in any city in which there was a pure and good supply of water, and proper means were taken to guard against the sources being polluted by any of the specific choleraic poison.

In support of this idea, I would desire to call attention to the cities of Toledo, Seville, Malaga, and Madrid, in contradistinction to such places as Aranjuez, Saragossa, Granada, and Valencia.

I will commence with Madrid. This city, whose population at the last census was 397,816, suffered very severely, indeed, under the last epidemic of 1865, when during several days immediately following a very severe thunder-storm the number of cases varied from 800 to 1,200 per day. The first invasion of last year took place in Madrid on May 20, and the disease ran its course during the whole of the summer, gradually disappearing towards the end of the month of September. The total number of cases during the whole of the period was 2,207, and the deaths 1,366. The total number of cases therefore during the five months that the disease never abandoned the city was barely more than what occurred during two days only of the epidemic of 1865, being little more than one-half per cent. of the population. I think, therefore, we may safely say that the disease never truly assumed an epidemic form. The greatest number of cases, as was to be expected, took place during the months of July and August; the first notable increase took place on July 25, and the first notable decrease on August 13.

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\* Cholera in its relation to water supply. By George Higgin, 1886.



In connection with this it is interesting to note that Madrid was subject to severe thunderstorms during the latter end of July, and that 119 millimeters of rain fell during the month. These storms began on the 13th, and were especially severe on the 23d, 24th, 26th, 27th, and 31st, the first notable rise in the cases of cholera occurring between the 25th and 28th. As a general rule no rain falls in Madrid in July, and the occurrence of these severe thunderstorms and heavy falls of rain was quite phenomenal.

The new water supply from the Guadarama Mountains was completed shortly before 1865, and the greater part of the drainage was also completed; but at that time the new water supply had scarcely come into use, the large majority of the houses being supplied from the old fountains which existed in various parts of the city. During the last twenty years the use of the Lozoya water has become very general, and an ample supply has been provided for washing the streets and flushing the sewers.

Madrid is now well drained; the sewers are built upon the Paris model, and are not what an English engineer would consider as a good type for self-cleansing purposes, but the fall is, in almost every case, very great, and it is not probable that there can be any collection of fecal matter at any point. The connection of the street gullies with the main sewers is made without any trap, and good ventilation is thus provided. As regards the outfall of these sewers, nothing satisfactory can be said. The mouths of the main sewers, which are seven in number, all discharge on the southern side, between the station of the Saragossa Railway and that of the Northern.

The question of the proper disposal of the sewage in Madrid, as in London, has never been decided, and pending this decision the sewers were completed only as far as the outlying houses of the city, and the sewage was then allowed to find its way down to the Manzanares in the best way it could. During the time the question has been waiting a solution the town has extended, and houses have been built along the course of these open sewers. As might have been expected, the first serious outbreak of cholera occurred about these spots, the original germ of the disease having been imported from the neighborhood of Valencia, where the cholera was then raging.

The existence of the disease having been established beyond doubt, one of the first acts of the municipality was to attend to the water supply. There existed 11 ancient sources, which supplied 85 taps or fountains, 22 of which were public ones, at which water-carriers were allowed to fill their barrels, and the remaining 63 belonged to groups of houses. In spite of the excellent supply brought in from the Lozoya, these old sources were still a great deal used by the inhabitants—many, from old habits, preferring to use the same water which their fathers had used; many not willing to incur the expense of laying on the new supply. In view of the impossibility of effectually guarding against the possible contamination of so many sources of supply, the municipality, by decree, on June 18, closed all the old ones, with the exception of that of La Fuente de la Reina, which supplies 5 public fountains and 4 private ones.

The central Government undertook the custody of the Lozoya aqueduct, the municipality took charge of the Fuente de la Reina. The Lozoya water is drawn from the sources of the river Lozoya, in the Guadarama Mountains, some 50 miles to the north of Madrid.

The river takes its rise in the granite formation; the water is excellent, and from the uninhabited condition of the country through which the river flows before the intake, it is not exposed to direct contamination from any specific poison. From the intake of Madrid the water is conducted by a series of magnificent works, partly covered, partly uncovered, to Madrid, where it is received in covered reservoirs before being distributed in the city; the service is continuous, no cisterns being used. During the whole time of the existence of cholera in the city the uncovered portion of the aqueduct was patrolled by armed guards, no one being permitted to approach without a special order.

Accompanying the extensive report on Madrid, by Don Alberto Bosch, amongst other plates is an excellent map of the city, showing, by a red dot, the situation of every case of cholera that occurred; they are seen pretty thickly scattered about the uncovered exits of the sewers, and on both sides of the river Manzanares, which is in fact, in summer, an open sewer, and

in the lower portion of the city overlooking the river, and there is scarcely any part of the town where a dot is not to be found; but with the exception of the points mentioned, the cases occurring in the remainder of the town seem to be all isolated ones; in extremely few cases do two dots occur together, showing that the disease was more of a sporadic than of an epidemic character.

Now let us take the case of Toledo. This ancient capital of Spain is certainly not a city that could be taken as a model of sanitary arrangements, on the contrary it seems to be admirably adapted to form a good nest for any wandering epidemic, and yet, although the cholera entered it in the summer of 1884,\* and did not finally leave it until the autumn of 1885, the total number of cases, according to official returns, did not exceed 200, of which about one-half were fatal. The population of Toledo is over 20,000, so that the percentage of choleraic disease was only 1 per cent. of the population for the two seasons.

Toledo was supplied with water from the river Tagus, which flows round the city, the water being lifted by pumps. Above Toledo, on the same river, is situated Aranjuez, and above Aranjuez again, on the Manzanares, which is a feeder of the Tagus, is situated Madrid, in both of which towns the cholera existed in 1885, being unusually severe at Aranjuez. The governor of the province, recognizing the suspicious character of the water, stopped the pumps, and obliged the inhabitants to send for their drinking water to a distant spring; he even forbade any one to bathe or wash clothes in the river. The measure was a strong one, but it saved the city.

Let us next take Seville. Seville is an important city, the third in rank in Spain; it contains, according to the census of 1877, 134,318 inhabitants; it has, strictly speaking, no drainage; a few ancient sewers exist for carrying off the rain-water from the lower portion of the city, but sewerage for houses does not exist. The sewage goes into cess-pools, which are in most cases situated just outside the house and under the street; the inhabitants are extremely cleanly in their habits, and the outsides of their dwellings are constantly whitewashed, but it is not a healthy city—typhoid fever is endemic, and the death-rate rises in some parishes to 35 per thousand.

Seville is situated on the river Guadalquivir; of this the rivers Darro and Genil, that flow through Granada, are feeders. As regards its water supply, one suburb of the city called Triana, containing about 30,000 inhabitants, is situated on the western side of the river. This portion is almost entirely inhabited by the poorer classes, and they drink generally the water of the river. The rest of the town is supplied from an ancient Roman or Moorish aqueduct, the water being brought from an underground spring near the town of Alcalá, about 9 miles to the east of Seville; this water is carried by a tunnel about 2 miles in length under the town of Alcalá; it is then carried in a covered conduit to within a short distance of Seville, and from thence by an aqueduct made by the old Moors. The water is excellent.

An English company has quite lately erected engines at Alcalá, by means of which they pump up to a covered reservoir above the town the water from two other springs situated also at Alcalá, but on the opposite side of the river Guadaira, which flows past the town. This water is carried from the reservoir into the town by iron pipes, and distributed under considerable pressure; in character it is pure and excellent; the springs rise from the base of the sandstone at a short distance from the engine house, and are carried across the river by an iron pipe. The cholera broke out in Granada on July 14, 1885, but already on June 14 of the same year the authorities of Seville, by way of prevision, had prohibited the use of any water from the river, either for dietetic or other purposes; had authorized the English company to lay a temporary pipe across the bridge which connected the city with the Triana suburb, and had opened a number of free taps from which the inhabitants of this suburb could draw the new water.

The old Moorish supply was scarcely susceptible of contamination, as the conduit was covered for the greater part of the way, and where it ran over the aqueduct no one but the municipal guards had ever been allowed to pass; guards, however, were stationed day and

\* It is very probable that cholera did not exist in Toledo until after the epidemic began in Játiva during the spring of 1885, although this belief had been somewhat prevalent.



night at the springs from which the English company derived their water, and no one was allowed to approach them without permission.

The cholera raged fearfully in Granada during the months of July, August, and September; it descended the river Genil, which runs through Granada, and attacked the towns of Herera, Ecija, and others in the province of Seville. It broke out also at Córdoba and other towns on the Guadalquivir, of which the Genil is an affluent, and it broke out in Palma, Utrera, Puerto Real, Puerto Santa Maria, and Cádiz, forming a circle around Seville, but the city itself escaped almost completely. Toward the end of September 9 cases occurred in one quarter of the city, of which 7 were fatal, but the disease did not spread; none of the five houses in which these cases occurred were connected on to the water supply, and it is possible that they may have used well or river water, although it is not known. Jérez, which lies about half way between Sevilla and Cádiz, and close to the town of Puerto Santa Maria, which was attacked by cholera, escaped also from the disease. This town possesses a very excellent water supply, brought down some few years ago from a spring in the mountains by a native company at a cost of £300,000.

Málaga has a population of 115,882. This city is in even a worse sanitary condition than Seville as regards its drainage, and a great deal worse as regards its cleanliness. In the old portion of the town the streets are narrow, unventilated, and intolerably filthy; the climate in summer is almost tropical.

It is difficult to obtain reliable data as to the cases of cholera in Malaga, as attempts were made to prove that no real cholera existed in Malaga, but there can be no doubt but that from June to September the cholera did exist, and it is probable that during the whole of the summer there occurred some 200 or 300 real cases of Asiatic cholera. But the disease never became epidemic, although to all appearances the city offered a most excellent medium for the propagation of the disease, and on all former visitations had suffered very severely. But Malaga, during the last few years, has been provided with an excellent water supply drawn from some springs situated at Torremolinas, on the coast to the westward of the city, and piped from thence into the city, and although the precautions adopted were not so complete as those at Seville, yet a more or less successful attempt was made to prevent the use of any other water than that brought from Torremolinas.

We have now examined the case of the few towns in Spain that possess a pure supply of water drawn from springs not liable to any specific contamination, and we have seen that in all cases where such a supply existed, the cholera, although present in all of them, never made any headway or became truly epidemic, although in every case, except that of Madrid, there was no proper drainage, and the sanitary conditions were in many cases as bad as they could be.

Let us now look on the other side of the picture. We will commence with Granada—population, 76,005. As regards the sanitary arrangements, this city is on par with Malaga; about one-tenth of the town is drained, but the sewers are of a very inferior class. The city is supplied with water by canals derived from the Genil and Darro, the two rivers which serve to irrigate the magnificent plain which spreads around it. A small portion is supplied from a spring called La Fuente Grande de Alfacar. The canals are uncovered and exposed to all kinds of contamination.

Through the streets the water is conducted in earthenware pipes, after the style of the Moors; many of the pipes are the original ones put down by these people before the conquest of the city by Ferdinand and Isabella. The cholera broke out about the middle of July. It is supposed to have first been brought in by some laborers who had arrived from Murcia, where the cholera was raging. It spread with frightful rapidity, and by the middle of August the official number of cases reported was over 450 per day. It died out, or rather wore itself out, about the middle of September. The total official returns give a total of 6,471 cases, and 5,093 deaths, but in the city itself these returns are said to be much underestimated; some, indeed, say the numbers should be doubled.

No attempt was made, as was done at Toledo with such excellent results, to suppress the old water supply, and the epidemic took in a short time such alarming proportions that the local authorities were completely paralyzed. It was difficult to carry on the interment of the bodies,

and at one time from 400 to 500 corpses were lying piled up in the cemetery awaiting interment.

The course of the cholera may be followed down the rivers Darro and Genil, the infected waters carrying death wherever they were used for drinking purposes.

Murcia—population, 91,805—from which the cholera was imported into Granada, suffered heavily also. It was carried into the plains of Murcia by the waters of the river Segura, from the baths of Archena, and it was imported into Archena by some invalid soldiers, who were sent to the baths from the infected districts around Valencia. The plain of Murcia is irrigated by the waters of the Segura, and the disease commenced in this district with the death of a laborer who had drunk the water of one of the irrigation canals. The inhabitants of Murcia and of the plain use principally water from the irrigation canals or from the river; this water is usually stored in large jars similar to those which held Ali Baba and his forty thieves, and among well-to-do people it is customary to keep a year's supply on hand; that is to say, the water is allowed to repose for one year, before use, in a reservoir or *aljibe*, constructed on purpose, or in some of those large jars sunk up to their necks in the ground; by this means it becomes perfectly clear, cool, and palatable. The poorer classes are, as a matter of course, not able to take these precautions, and have to drink the water from the canals, or after a few days' repose only.

The epidemic raged principally amongst the little cottages scattered thickly over the plain, or garden, as it is called, but the disease never developed itself in Murcia as it did in Granada, and the city itself escaped better than might have been expected. May this not be attributed to the fact that the greater part of the people in the city were drinking water collected in the foregoing year, before the cholera had appeared at the sources of their water supply? And if this be so, may we not anticipate a fresh outbreak this year, if the choleraic poison or germs are capable of outliving a year's repose and darkness?

In reference to water supply and cholera, no case is so instructive as that of Valencia. This city is fairly well drained, as drainage goes in Spain, and as regards cleanliness is certainly in a better situation than Málaga or Granada. The water supply is derived from the river Turia; it is taken from the river near the town of Manises, about  $3\frac{1}{2}$  miles above Valencia; it is passed through sand filters situated between Manises and Mislata, and is stored in a covered reservoir, from whence it is conducted by iron pipes, a distance of about  $1\frac{1}{2}$  miles, into the city.

In one of the interesting letters written by the special correspondent of the Times, during his tour of inspection of the cholera districts, a very clear description is given of the track taken by the cholera from its starting point in Alicante, where it had broken out at the latter end of 1884, to Valencia in 1885. During the course of the year 1884 the disease had crossed the frontier of the provinces of Alicante and Valencia, and established itself in Játiva,\* a somewhat important town, situated on one of the affluents of the Júcar—this and the Turia being the two rivers whose waters are used for the irrigation of the wonderful “Huerta,” or Garden of Valencia. During the winter the disease lay dormant, but it broke out in the spring of 1885, and traveled rapidly down the river to Alcira, attacking the various towns situated on the river itself, or on the canals derived from it.

The epidemic was severe at Alcira, but as the Times correspondent suggestively remarked, it ceased as soon as the inhabitants gave up drinking river-water and took their supply from a spring situated at a considerable distance from the town. From Alcira it traveled across the net-work of canals till it reached the river Turia. The Times correspondent says: “It came very near Valencia, and yet never touched the capital till it had worked right around.”

At last, in the middle of May, having crossed the water supply of the city and thoroughly infected the river, it attacked the city right royally, and by the end of June the number of cases had risen to 700 daily, out of a population of 143,861. The disease died out in September, having, according to the official accounts, attacked, during the four months, 4,234 people.

We will now turn to Saragossa. Saragossa, the capital of the ancient kingdom of Aragon, is situated on the right bank of the river Ebro; it contains 84,575 inhabitants, and is an impor-

\* Cholera did not appear at Játiva until the spring of 1885. It dragged its slow course through the winter of 1884-'85 in the vicinity of Gandia, in the Province of Valencia, and was carried from Gandia to Játiva in the spring.



tant city. Like most Spanish towns and cities it has no sewers; fecal matter is collected, as in Seville, in cess-pools, which are periodically emptied.

Its principal water supply is derived from the canal de Aragon, which in its turn draws its supply from the Ebro, near Tudela. This canal was intended principally for navigation, and is now used for this purpose, as also for irrigation. It passes at a short distance above Saragossa, and the town supply, after being drawn from the canal, is stored in reservoirs, and, after depositing its mud, is then passed through charcoal filters. Some of the inhabitants of the city drank the water from an irrigation canal taken from the river Jalon; some used the waters of the Ebro, which flows close past the old walls of the city.

The disease broke out in Saragossa shortly after the middle of July, and the number of cases during the time the epidemic raged was close upon 10,000. The proportion of deaths was small, thanks to the heroic and energetic conduct of the authorities and the people. Sometime before the commencement of the disease in the city, a number of small towns on the banks of the Ebro and the Jalon had been attacked by the cholera; there was therefore ample opportunity for the infection of the water supply. Against such contamination the only protective measure as regards the general supply was the filtration through charcoal; as regards the Jalon water, there was no protection. This source of supply was, however, ultimately stopped by the authorities, who prevented the water reaching the city, with a notable result as regarded the decrease of the epidemic in the quarter served by them.

It would be interesting to follow out still further the line of inquiry I have adopted, but the examination would be too prolix for the present purpose. The cases I have presented are typical ones; they might be increased *ad libitum*, but I think they are sufficient for my purpose. From an examination of them it would appear as though, in the case of cholera, drainage and sewage are secondary subjects, the primary one being the water supply. We have seen that the cities of Toledo, Seville, and Malaga, although in bad condition as regards their sewerage and general sanitary arrangements, yet escaped from any serious attack of cholera, whilst Murcia, Valencia, and Saragossa suffered most severely, although in their case the sanitary arrangements were certainly not worse, but if anything better, than the three former cities. But in the case of the three first-named cities each one enjoyed a supply of water drawn from springs situated at a distance from the city, and carefully watched and guarded to prevent any contamination, and the exclusive use of this water was rendered imperative by the authorities.

In the case of Valencia, Saragossa, and Murcia, we have a supply drawn from rivers subject to contamination from various sources, against which the only protection was that furnished by the doubtful process of filtration.

There can be no doubt that the cholera attacks in preference those who live under unsanitary conditions, and whose habit of body is by this means prepared to receive the germs of any disease that may be prevalent.

There is no doubt that the virus can be conveyed about from one place to another, like small-pox, typhus, and various other diseases, either by clothes or in the human body, and where it finds a proper medium it will develop itself and extend; but like these other diseases, it can in these conditions be isolated, fought, and conquered, but without doubt the medium *par excellence* for the spread of cholera poison is water, and more particularly so when water so infected is used for dietetic purposes. When it gets possession of the water supply of a city, no bounds can restrain it; there is but one resource, and that is the cutting off of the water.

We do not yet know in what the choleraic poison consists; it is, in all probability, a micro-organism of some sort which is capable of very rapid development in water, but it can not be yet said what is the particular micro-organism which produces cholera. The "comma-bacillus" of Koch has not been accepted by scientific authorities; on the contrary, very high ones deny altogether its identity with cholera, and assert that it is to be found in the mouth of every healthy person.\* Whatever the specific germ may be, it is at least doubtful whether

\* This author has committed the common error of that date of assuming that common curved bacilli, closely resembling in form the comma bacillus of Koch, and found to be rather widely distributed, were identical with the latter, an assumption which even the original promulgators thereof were subsequently forced to abandon, as is shown later in this report.

any filtration will intercept it; from the experience obtained at Valencia and Saragossa it appears evident that neither sand nor charcoal will do so.

In a paper read recently at the Institute of Civil Engineers, Dr. Percy Frankland asserts that the London water companies do, at the present moment, eliminate 96 per cent. of all the micro-organism in the Thames water by simple filtration through 3 feet of fine sand. This may be so, but it is equally certain that filtration through sand, even at a slow speed indeed, will not eliminate the minute particles suspended in waters of a deltaic character, and which give such water its peculiar color. If sand is incapable of intercepting these particles, it may also be incapable of intercepting the specific germs or poison that produce cholera in the human body.\*

Filtration is, at the best, but a doubtful proceeding for the purification of water. It is impossible to control effectually the speed of the filters; they vary at every moment, and although a mean term may be arrived at by taking the area of filter beds and the volume of water filtered in the twenty-four hours, yet this really affords no reliable guide as to the actual speed at which the water has passed the filters. It is probable, nay, almost certain, that out of a given quantity of water, no two gallons have passed at the same speed, and it is possible and probable that one-half of the total volume may have passed the filter at double or treble the speed of the rest.†

To insure immunity from contamination, the only real and practical method appears to be that of capturing the water at a pure source and conducting and delivering it in such a way as to render it impossible that any specific germ or poison should have obtained access to it. In the matter of cholera, for instance, with the experience of Valencia and Saragossa before us, one can not feel any confidence in water which is taken from a river liable to so many sources of contamination as is the Thames, and it is at least doubtful whether any system of filtration would be capable of eliminating cholera poison from such waters. It is extremely probable that simple filtration through sand will not do it.

In some of the larger towns there are public water-works, but it is rare that the water supplied by these is of an excellent quality. The water is subject to contaminations in its course from the source to the point of final distribution frequently in the same manner as that above described when speaking of the public water of the city of Palermo. The rule is that the water is introduced into the town and often distributed even there by means of open water trenches through which the water flows slowly by the force of gravity. This is particularly the case in the city of Granada which for a time during the last epidemic so frightfully suffered from cholera. In that city the large water jars already mentioned are in use by many of the upper classes of the inhabitants for the storage of water. Many of the towns best supplied with public water in Southern Spain owe their supply to works built either by the Romans or the Moors at the time of their dominion in Spain. The city of Seville is abundantly supplied with water of an excellent quality from springs a number of miles from the city. The water is brought to the town in aqueducts built by the Romans, which are even at present in a fair state of preservation. The chief fault to be noted concerning the water supply of Seville is that the aqueducts are uncovered throughout most of their course and the distribution of the water furnished by them is made throughout the town by means of gravity alone. The old Roman water supply of Seville is supplemented by water-works under the direction of an English company. The water supplied by this company is also of a fair quality and is distributed throughout the town by iron pipes, under considerable pressure. Besides these public water supplies, there are a certain number of private wells which are more or less extensively used by the neighboring inhabitants.

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\*Again this author is in error. The city of Calcutta is located on the river Hoogley, one of the delta outlets of the Ganges. The muddy water of this river becomes perfectly limpid after filtration through the sand beds of the public water works of that oriental city.

†The practical experience of some sixty cities in England and on the continent of Europe, among them London and Berlin, demonstrate amply the efficiency of filtration through sand beds as a means of purification of water originally bad.



## DRAINAGE.

The next subject which I will discuss is that of drainage, both public and private. In the great majority of Spanish towns, and, in fact, in nearly all of the smaller villages, there is an entire absence of any artificial system of drainage; the sole means of the disposal of the natural accumulations in the streets is the downfall of rain and the flow of the surface water down natural declivities of the surface of the ground. In some of the more advanced smaller towns the municipality makes some, usually inadequate, provision for the removal of filth from the streets by manual labor, and these efforts are sometimes to a considerable extent aided by the desire of the agricultural portion of the inhabitants to obtain, without purchase, manure for the enrichment of their fields. In most of the smaller towns and villages there is no such thing as household drainage, the houses not even being provided with a *cloaca negra*, the excrement and all other household filth being almost universally allowed to accumulate in the courts and upon the unpaved ground floors of the dwellings of the poorer classes, these accumulations being customarily removed only once or twice a year and transported to the fields for the purposes of fertilization. In Spain the abominable practice of throwing the night-soil from the windows into the streets is even more extensive than it is in Italy and France.

In some of the larger towns and cities the existence of sinks or *cloacas negras* under the entrance halls of the larger dwellings, and in part also under the pavement of the street, is the only provision which is made for the collection of the household sewage.

In speaking of the dangers of the contamination of drinking water stored in large sunken terra-cotta water jars, I have already alluded to the faulty construction of these *cloacas negras*. When they exist they serve as a reservoir not only for the kitchen slops and materials from the water-closets, but also sometimes as a receptacle for the rain-water from the roof. This latter service is, however, usual only when the *cloaca* is in connection with the street gutter or the public sewer by means of an overflow pipe. These *cloacas* are emptied as a rule not oftener than once in several years, unless there is a demand by the agriculturists for the material contained in them, as a manure. The man-hole through which the contents of these sinks are to be removed is, in most instances, in the floor of the hallway, just inside the street doorway, and it is the rule that it is badly closed by an imperfectly fitting stone flag, which is usually furnished with a ring for its convenient removal. So that the air of the hall, and of the chambers communicating with it, is very constantly poisoned by emanations from the decomposing matter contained within. In many of the towns, and indeed in some of the larger cities of Spain, the man-holes of these household sinks are upon the sidewalks of the public street, and the sensibilities of the traveler are constantly shocked in his meanderings through the city in search of objects of interest by the horrible odors which render the street almost impassable while the rotting contents of the *cloaca* are being removed before his eyes and under his nose, the chosen time generally being the middle of the day. Even in the streets of the attractive city of Seville this is a most common sight.

In houses where there is a *cloaca* there is usually also a system of water-closets, and whether the dwelling is the abode of a single family or a number of families, each of which occupies a story of the house, the almost universal plan of construction of the building locates the water-closet in one corner of the kitchen. In these cases the water-closet does not constitute a separate room, but is simply walled off from the rest of the kitchen by a partition which rises only a little higher than the head, the air of the water-closet and that of the kitchen having free circulation over the top of the partition. As the water-closets are located one above the other in the various stories in the house, there is a main drainage pipe just on the outside of the house wall, commonly on the face toward the interior court, running from the top to the bottom of the dwelling, and terminating below in the *cloaca*. The water-closets of the different stories communicate with the main vertical drain by means of pipes leading from the pan in the closet, and at the same time there is no possible means of adequately flushing them. Furthermore, the kitchen table very commonly adjoins the partition of the water-closet, and the little sink attached to it for the collection of the refuse water commonly at one end of the table connects with the pan of the water-closet by means of a short pipe. It is safe to say that not once in a thousand times is such a thing as a trap in these pipes known.

While discussing the sanitary condition of the Italians, I spoke of the means provided in many of the larger houses for the drawing of water by means of buckets raised from the well to the top of the house. This same arrangement usually exists in Spain in the houses provided with *cloacas*, and as the water thus drawn is most frequently needed for use in the kitchen, it is under or by the side of this portion of the house that the water-well is located. It can thus be seen that it is in dangerous proximity either to the *cloaca* or to the main vertical drainage pipe, already alluded to, which leads into the latter. These vertical drainage pipes are frequently seen to be in a leaky condition, and the more fluid part of the matter which they lead off finds its way down along the exterior of the pipe and the wall of the house, and finally even drips almost directly along the wall into the well. In fact the contamination of the well-water in these cases is such a commonly recognized fact that it is a rare thing to find an inhabitant of one of these houses who will admit that this well-water is used for drinking purposes, insisting as a rule that it is solely employed for other domestic uses, such as cleaning the floors, dish-washing, etc.

I have already said that in the great majority of Spanish towns there is no public provision for the disposal of surface sewage. In comparatively few towns, mainly of the larger size, and in the cities, is there a so-called system of underground sewers. In some of the cities, where a system of underground sewers is most extensive, they are in the main the identical ones which were constructed by the Romans or by the Moors, and so little attention has been paid to their condition for generations, and even centuries, that it is not seldom that the town authorities possess no chart or other record of their location. The consequence is, very naturally, that even where the sewers do exist they are in a most imperfect state. They are, in the first place, badly formed, imperfectly walled, not properly slanted and greatly if not altogether obstructed. This description of the state of the public sewers in Spanish towns, where they exist, applied to every one that I have visited, with the exception of Madrid. It is, therefore, extremely probable that the existence of underground sewers in such condition constitutes a menace to public health rather than a benefit.

These public sewers, where they existed, were intended mainly for the disposal of the surface water and the drainage of the streets, including the rain-water which is collected from the roofs of the houses. There are very many towns and even cities where the connection between the *cloacas* and the street sewers, where the latter exist, is the exception rather than the rule. The destination of the contents of the public sewers, when they are discharged at all, is usually the public streams, rivers, and irrigation canals.

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*CHOLERA IN ITS RELATION TO MODES OF EXTENSION, NATIVE CUSTOMS, HYGIENE, PROPHYLAXIS, ETC., IN SPAIN.*

The writer caused to be printed a circular of interrogatories relating to the subject of cholera, and distributed it to some 2,500 physicians in the Spanish cities and towns which had been afflicted with cholera. Thanks to the courtesy and interest of the Spanish physicians, a large number of replies were received.\* The following is the translated form of that circular:

INTERROGATORIES CONCERNING THE RECENT CHOLERA EPIDEMIC IN THE CITY OR VILLAGE  
OF ———, IN THE PROVINCE OF ———.

It is desired, in order to avoid useless repetitions, that the reply given to each specific question be accompanied by the corresponding number of the interrogatory. Especial attention is invited to questions No. 1, 2, 5, 6, 7, 8, 11, 15, 18, 19. If it is impossible to reply to all of the questions, please respond to those which you can conveniently.

- (1) If your town has been attacked by cholera during the last epidemic, when and how was the disease introduced?
- (2) When and how did the cholera spread and become epidemic?
- (3) Was the propagation of the disease rapid or gradual?

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\*As already related, similar circulars were also addressed to the physicians in the afflicted cities and towns of France, but through lack of courtesy or of sufficient scientific interest these communications were as a rule ignored.



(4) Was the cholera propagated from one or from several centers of infection? What was the location of these centers?

(5) What measures were adopted and put into execution to prevent the introduction of the disease in the town?

(6) What measures were adopted and enforced in order to prevent the first cases from producing an epidemic? What restrictive measures were adopted and enforced after the development of the epidemic began? At what date were the measures enforced?

(7) State the character of the public supply of drinking water. By what means is this drinking water conducted into the town and distributed there? What per cent. of houses are supplied with this drinking water? Are the upper stories supplied with this water? What other kind of drinking water is there?

(8) If there are villages or cities situated along the course of the stream which supplies your town with drinking water, up-stream from the point where that water is taken, were those villages visited by cholera or not? In the affirmative case, at what date and to what extent? What were the names of these villages, and how far distant from the point where the drinking water was obtained? What was the rapidity of the current during the prevalence of the epidemic?

(9) Whence does the water proceed which is used for irrigation? Does it flow from other villages before reaching yours? If so, were they invaded by cholera, and at what date and to what extent? What is the distance by the irrigation canal to said villages?

(10) What was the character and extent of public sewerage of your town, and what the nature of household drainage? What connection existed between the two?

(11) What relation existed in your town between the introduction and propagation of the cholera and the supply of drinking water? What relation had the cholera with the public and private sewerage?

(12) What parts of your town suffered most from cholera? What was the condition of the inhabitants of those parts, and what was the state of the sewerage in the same, as compared with other parts of the town less attacked?

(13) What were the meteorological, hygienic, and telluric conditions of your town before, during, and after the epidemic? (This question embraces the nature of the soil and subsoil, its moisture and dryness, the state of vegetation, etc.)

(14) What was the daily progress and number of the attacks and deaths by cholera in your town?

(15) What appreciable influence did the preventive measures above mentioned have upon the course of the epidemic?

(16) What are the other diseases common in your locality which so resemble cholera that at the beginning it is difficult to distinguish between them?

(17) What treatment has proved most efficacious in combating the cholera?

(18) If anti-choleraic inoculations have been practiced in your town, what were the names of the operators, method of operating, and the dates of the inoculations? Were the inoculations as a general rule practiced among that class and that ward which have suffered most from the cholera? What are the facts and statistics, of which you have personal knowledge, respecting the harmlessness or danger and the utility or inutility of the procedure of Ferrán?

(19) What number of individuals have been, according to your personal knowledge, attacked by cholera twice or three times during the same epidemic? If you have knowledge of such cases please relate the full details.

(20) What are the history and results of the quarantines, *cordons sanitaires*, and fumigations practiced in your village during the continuance of the cholera epidemic in Spain?

(21) What measures have been adopted to prevent the reappearance of cholera during the next season, and what improvements have been adopted with respect to public hygiene, supply of drinking water, and sewerage?

(22) Have any vestiges of cholera remained in your population during this or the past winter, either as isolated cases, which have appeared from time to time, or in the form of a localized epidemic?

(23) What has been the number of deaths in your town for the last five years?

(24) If your town has not been invaded by cholera, or, on the contrary, if it has been so one year, and not the other, to what was the immunity attributed?

(25) What was approximately the number of persons who abandoned your town during the epidemic?

From the large number of replies to these circular letters the following are selected as examples of the valuable information thus obtained relative to the cholera in Spain.

REPLY TO INTERROGATORY CONCERNING CHOLERA IN CATRAL, IN THE PROVINCE OF ALICANTE.

(1) On the 15th of June, 1885, the cholera epidemic began in this town without there having been during the previous days a suspected case. On the same day the supply of the water for irrigation of the *huerta* of this village began. The person who was first attacked owed his misfortune without any doubt to ingestion of the water flowing in the irrigation canals.

(2) On that same day and the following days the epidemic appeared.

(3) It spread in a rapid manner.

(4) There were no centers of infection; the disease was attributed to the water.

(5) The first measures adopted by this sanitary board were cordons.

(6) Isolation of the first cases; after the epidemic was declared, intercommunication of the inhabitants was left free.

(7) Irrigation water from the river Segura, supplied at regular intervals; all the inhabitants use this water.

(8) There are various villages and towns located along the current which supplies this town with drinking water, above the point whence our water is taken, and these villages and towns were visited by cholera before this place was. Those places are Alcantarilla, Alguazas, Molina, Mula, Blanca, Cuza, Calasparra, etc.

(9) The irrigation water of our *huerta* is the same as that destined for drinking, and before reaching this place passes by the towns named in No. 8. These towns were invaded some fifteen days before this town was. From Cortal to Callosa the distance is about 6 kilometers, to Orihuela 15, to Murcia 36; these are the nearest.

(10) There are no sewers; the drainage is accomplished by the trenches which are constructed for the removal of the surplus irrigation water and that which filtrates from the adjoining lands.

(11) Immediately upon the arrival of the water destined for irrigation and drinking, the cholera developed.

(12) The whole town, but especially those parts inhabited by the lower and the laboring classes.

(13) In this town intermittent fevers of all types are endemic; this is to say, that malaria reigns the whole year because the soil is damp and is covered with vegetation, the whole environment being *huerta*.

(14) The following shows the daily mortality from cholera:

Date.	Deaths.	Date.	Deaths.	Date.	Deaths.	Date.	Deaths.	Date.	Deaths.	Date.	Deaths.
June 16	1	June 30	4	July 14	1	Aug. 1	1	Aug. 16	1	Aug. 31	2
17	3	July 1	2	15	3	2	1	17	3	Sept. 2	1
18	1	2	2	16	1	5	3	18	2	4	2
19	4	3	7	18	1	6	3	20	1	6	1
20	3	4	3	20	1	7	3	21	4	8	1
21	8	5	2	21	2	8	3	22	1	10	3
22	3	6	2	22	2	9	1	23	2	14	1
23	7	7	1	24	2	11	2	24	1	18	1
24	5	8	3	25	1	12	1	25	2	20	1
25	1	10	1	27	1	13	2	26	3	27	1
27	5	11	1	28	2	14	4	29	3	Oct. 6	1
28	3	12	2	29	1	15	2	30	6	15	1
29	3	13	2	31	1						



On the 15th of October the epidemic finally disappeared.

(15) I may say—nothing.

(16) Pernicious intermittents, entero-colitis, etc.

(17) Various methods of treatment were employed, but preference given to none.

(18) No inoculations performed.

(19) None.

(20) Quarantines and cordons gave no result; fumigation prevented in some cases contagion between members of the same family.

(21) Up to the present, those suggested by hygiene.

(22) After the disappearance of the epidemic no vestige of the disease was observed.

(23) The number of deaths in the last five years—that is, from 1st of January, 1881, to the end of December, 1885—is 739.

(24) The cause to which the immunity of the previous year is attributed is the fact that cholera did not spread among the villages along the banks of the river Segura, for whenever in the past these had been invaded this village has infallibly been attacked, and the common belief is that the water used for irrigation and drinking is the carrier of the cause of the disease. During the previous year, when the cholera appeared in Novelda and Monforte, this town was not invaded notwithstanding the frequent communications which existed between those villages and this.

(25) Only five families left the town during the epidemic.

JUAN BERNAL YAGÜE.

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REPLY TO INTERROGATORIES CONCERNING CHOLERA IN ELCHE, IN THE PROVINCE OF ALICANTE.

(1) Our town was invaded by cholera in the two last summers, but the disease did not occasion the ravages which it has caused in former visitations. The first cases in the year 1884 occurred on the last day of August, and by the end of September the epidemic had almost ceased. In 1885 the first cases appeared in the last of July, and the last cases occurred before the end of August. To say when and how the disease was introduced would be to beg all that is questioned. The cholera was already committing ravages in the neighboring villages, when three persons were attacked on one and the same day, who apparently had had no communication or contact with persons or things from the infected villages. It should be taken into account that two months before the registration of the first case of cholera all the inhabitants of Elche were suffering with diarrhea.

(2) In two or three days after the first cases were registered, others occurred in several points of the population, and although the symptomatic picture was faithful to that of cholera, nevertheless there was a marked benignity in all of the cases.

(3) It was gradual.

(4) In the summer of 1884, the first attacked were in a ward located to the west and separated from the rest of the city by a river ordinarily dry, and that ward constituted the principal focus, the needy class being those who suffered most from the disease; but in the last summer the cholera attacked persons belonging to the middle class, and I can not explain the reason of this selection.

(5) When the cholera invaded the neighboring villages, the classic cordon was established here, nothing and no one from an infected place being permitted to enter without first undergoing the quarantine of observation in the lazaretto established about 3 kilometers from the town.

(6) Isolation of the families who had the misfortune to have a member attacked with cholera, accomplished by public guards, but this ridiculous kind of custody withdrew the families from the advice of the physician, and, on recommendation of the latter, authority was withdrawn from the guards. The principal measures were public and private hygiene in the first place, and in addition disinfection by chloride of lime, carbolic acid, and hyponitric acid. These measures were adopted a little before the registration of the first attack.

(7) By reason of its climate and soil, this town is pretty scarce of water, and on this account there is absolute necessity to make use of cisterns, which collect the rain-water used for general consumption. However, there are two public fountains which supply a certain quantity of water, which is conducted by means of canals (the word thus translated generally means sewer) from natural springs, distant from the city about 10 kilometers.

(8) The fountain water above mentioned passes through the *huerta* of Aspe, a village which is 3 kilometers distant from ours, and which was attacked by cholera prior to Elche.

(9) The water for irrigation proceeds from a dam in the course of the Vinalapó, the dry river referred to in note 4; the distance of the dam is 9 kilometers.

(10) Some of the houses have cess-pits which drain into sewers, which in turn empty into the irrigation canals carrying the water from the dam. The connection which these houses might have with the infection would be very evident in other towns, but here no general law can be deduced, for houses which had or had not this service were indifferently invaded.

(11) If the answer I give be "none," I should tell the truth, for here the facts either are against such a relation, or they have not been sufficiently tested.

(12) The answer to this question may be found in the replies Nos. 4, 10, and 11.

(13) This town is situated on the banks of the Vinalapó, at about 2 leagues from the sea, and its lands comprise 16 square leagues, almost entirely covered by vegetation, its *huerta* being noted for its palms and pomegranates. Its climate is almost always temperate, for the heats of summer are relieved by the breezes from the Mediterranean, and the rigors of winter are never here intense. Its soil is dry and of an argillaceous and cretaceous constitution in some places; the subsoil, however, is sufficiently moist, and it is owing to this circumstance that intermittent fevers are endemic here. The hygienic conditions of Elche are excellent, and the people are very cleanly.

(14) It varied between four and five per diem. It should be remembered that Elche contains some 22,000 inhabitants.

(16) Malaria during the whole of the year, principally in autumn, and in all of its forms; of late years there has been considerable of diphtheria.

(17) Since science has not discovered a specific with which to combat the disease, we had to limit ourselves to symptomatic indications. The opiates, principally laudanum, infusions of tea or camamilla, with a few teaspoonfuls of rum or brandy, cracked ice internally to check vomiting, revulsives, antispasmodics, etc., were our principal remedies.

(18) No inoculations were performed here, except in ten or twelve curious individuals whom Dr. Ferrán, in returning from Santa Pola, inoculated with a gram of prepared broth by means of the usual Pravaz syringe. Two or three of those inoculated experienced a phlegmon, which healed without trouble.

(19) One woman had sporadic cholera twice, and finally died of cholera.

(25) On account of the dissemination of the people through the country, it was believed that the ravages of cholera would not be as great as in former times. Fourteen thousand souls live within the town, and of these about 6,000 fled.

MANUEL CAMPILLO.

ELCHE, February 23, 1886.

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#### ANSWER TO QUESTIONS CONCERNING CHOLERA IN THE CITY OF CÓRDOVA.

(1) The cholera invasion of this capital occurred on the 25th of July, 1885, in consequence of the arrival at the railway station of a sick soldier coming from Granada who was taken to the general hospital under a diagnosis, made by a physician of the railway guards, of malarial fever. After he was admitted into the said establishment he presented the characteristic symptoms of cholera, and the cholera epidemic in this town dated from this case, although fortunately it did not have an extensive development.



(2) In consequence of the circumstance above cited and in spite of measures which were adopted both by the municipal authorities and by the board of health, the disease spread to other patients in the same hospital, especially in the insane department.

(3) The propagation of the cholera epidemic in this town was gradual, since, from the date of its commencement up to the 20th of October, when the last case occurred, there were only 69 persons attacked.

(5) The measures adopted before the commencement of the epidemic in this town were various; among others special mention might be made of the establishment of parochial committees, who constantly watched their respective districts in order that the inhabitants might practice the most scrupulous cleanliness in their dwellings.

The poor people who made application were gratuitously supplied with the necessary specifics for the daily practice of fumigation, disinfection, and cleaning of the room; at the same time those factories which by the gases that were produced in the process of fabrication were believed to be noxious to the public health were closed. At the railway station was established a permanent sanitary inspection of travelers, baggage, and merchandise arriving there from every quarter. Another similar corps of inspectors was established in the building called Calahorra, situated beyond the town limits at a point where various roads leading into the city converge, in order that those persons proceeding from infected points and presenting the evident signs of the disease might be lodged there. Furthermore, the biweekly examination of the drinking water which supplied the town was provided for; the use of the water of the Guadalquivir as well as fishing in the same was prohibited.

(6) In order to avoid the effects of such a devastating disease the gratuitous supply of rations of food for the convalescents was provided for; and in order to prevent as much as possible the development of the epidemic, a sanitary brigade was established for the closing of dwellings in which cases of the contagious disease occurred, disinfection and fumigation of such clothing and effects as might exist therein being first practiced, before they were permitted to be removed; the relations of the victim of the disease were placed in a house of observation and kept there a number of days at the public expense, while at the same time the patients were removed to the hospitals established for the purpose.

At a convenient time, and in order to provide for the medical attendance and supply of medicine to the sick poor who were attacked by the disease, the city was divided into three districts, and each one of these was supplied with physicians whilst a pharmacy for the gratuitous distribution of medicines which might be prescribed was established.

(7) The public supply of drinking water for this capital springs from the nearest mountain, and the water is conducted to the city in pipes partly of iron and partly of terra-cotta. A smaller proportion of the houses of the city directly use this water, for the majority draw this same water from the public fountains; there exists no other source of water supply.

(8) This question is answered in the previous reply.

(9) The water intended for irrigation proceeded from the fountains and the public tanks for the watering of animals; on account of its origin in the mountain the water did not pass by any neighboring village; the water of the Guadalquivir was prohibited.

(10) In a large part of this town there is a net-work of sewers which conducts the foul water to the river, where it is emptied. The houses which do not have any connection with the sewer are adequately provided with sinks.

(12) The portion of the town which suffered most from the epidemic was the district called Alcazarviejo, in which there were no sewers.

(13) The hygienic conditions of this town are excellent by reason of the cleanliness of its streets, its topographical situation, and the ventilation which all of its buildings enjoy.

(14) The progress of the epidemic was slight and slow, for from its commencement up to the end there were many days when no deaths from cholera were registered.

(18) It being resolved at the commencement by the board of health to authorize the prophylactic inoculations of Dr. Ferrán, the medical college of this town was directed to state whether they deemed this procedure advisable. The failure of the said college to express an opinion was without doubt the reason why this determination was not acted upon.

(21) In order to avoid the reappearance of an epidemic of cholera next season the hygienic measures placed in practice during the previous year were adopted.

(24) The cholera had not appeared in this town since the year 1866.

(25) The number of fugitives from this city by reason of fear of the epidemic was so small that their absence was not noticed.

F. R. SANCHEZ,

*President of the Municipal Council.*

CÓRDOVA, *March 24, 1886.*

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EXTRACT FROM A LENGTHY REPLY TO INTERROGATORIES CONCERNING CHOLERA IN THE CITY  
OF ALCIRA, PROVINCE OF VALENCIA.

(1) The first case of cholera occurred in this city on the 29th of March, 1885, and the last attack, which ended the epidemic, took place on the 1st of August. The manner of the introduction could not be precisely determined. The first victim who suffered its unfortunate effects resided in this city since the month of August of the year 1884, having at that time come from one of the villages of the province of Alicante, in which cholera was then prevailing. She had not left this city during the days preceding her attack; but it should be stated that a neighbor of hers, dwelling in the lower story of the house of which she occupied the second story, made weekly visits to the city of Játiva, in which cholera then existed. Furthermore, this first victim of the epidemic, as also the majority of the first cases, used drinking water from the river Júcar.

(2) The development of the epidemic in this city was distinguished by its slowness, and by the narrow limits of the diffusion which it reached at its height, notwithstanding the bad hygienic conditions present. The epidemic began on the 29th of March, when the mercurial column showed a low temperature, unfavorable for the development and evolution of the pathogenic cause of cholera. It continued its ascent during the months of April and May, but without its development assuming large proportions. Then began the intense heat of the middle of June, very favorable for the development of the cholera germs and consequently for the extension of the epidemic, which indeed at this time increased somewhat and reached its height in the first fortnight of July. The number of attacks was small during all the periods of the epidemic, when the bad hygienic conditions of this locality and the number of the inhabitants are considered and compared with all the other villages along the banks of the river Júcar.

(4) It can not be affirmed that the epidemic spread from a single focus. The majority of the first cases were isolated and occurred in different parts of the city, without having been in contact with each other. Nevertheless, during the first fortnight of April the attacks were much more numerous in that part of the city separated by the river than in the San Augustin quarter.

(5) This city was obliged to use cordons and lazarettos as protective measures, whilst considering the land quarantine system as unreliable, inefficacious, and prejudicial. Happy results were obtained from the use of disinfectants, and above all from the immediate sterilization of the cholera evacuations. This town had the honor and the fortune of having been the first to submit itself on a vast scale to the action of the prophylactic method of Dr. Ferrán, and obtained happy results therefrom.

(6) To the end of preventing the propagation of the epidemic, a circular was widely distributed among the inhabitants of the city recommending the rigorous observance of the laws of hygiene, and proscribing, besides, the use of the river-water, not only for drinking, but also for washing. An attempt was made to isolate the houses in which cases of cholera occurred; the dejections of the sick were sterilized, and the soiled clothing which they used was burned; and, finally, if the patient died the house was vacated.

(7) The majority of the inhabitants of this city use water from the river Júcar. Some use well-water, others water from springs located on the Aqua viva and La Murta Mountains. There are no reservoirs, or filters, or pipes for the conduction or distribution of the water.



(8) The river before arriving at Alcira receives water from Játiva, Manuel, and Puebla Larga, in all of which towns cholera had previously broken out, and it is probable that the current carried with it pathogenic materials proceeding from those towns, which are respectively distant from the city 16, 12, and 4 kilometers.

(10) In this city the system of sewerage is limited to a very small part of the town, and it serves to drain only the adjacent houses. Unfortunately the immense majority of the houses drain into the courts where the waste material used for agricultural manure decomposes. But if the rains are abundant or frequent, the water soon passes the capacity of the courts and escapes into the streets, flowing thence into the river Júcar.

(11) The first cases of cholera in this city occurred in persons who had used the water of the river Júcar for drinking; but the inhabitants soon appreciated this fact and all abstained from using it, water from the irrigation wells of the *huerta*, or from springs being substituted. It was impossible to see any difference in the number of attacks between those parts of the city where the sewers existed and those in which they were absent. Nevertheless it is worthy of mention that all the cases of cholera in this city occurred, with rare exceptions, among the lower social classes, who dwelt in houses with miserable hygienic conditions, and which had no drainage.

(13) The soil of this city is extremely porous and permeable. Constituted by the accumulation of detritus deposited by the river Júcar, which overflows and inundates frequently, it is composed of the siliceous sands and clays of which the majority of the mountains along the banks of the Júcar consist; moreover, adjoining this municipality, there exists an extensive zone of rice plantations, and since the terrible inundation of 1884, various parts of the *huerta* remain uncultivated and transformed into genuine marshes, whose miasmatic emanations have occasioned much malarial fever from which our inhabitants have suffered from the last of July until the unusual cold snap which occurred at the end of last October. As we have no astronomical observatory in this city, we can not state anything relative to the meteorological condition during the epidemic; we will limit ourselves to saying that during the months of March, April, May, and June, rain was very rare, and that great heat was experienced up to the middle of June.

(14) The course of the epidemic in this city was pretty slow since its duration extended from the 29th of March to the 1st of August; its diffusion was very limited, for of 16,000 inhabitants, only 559 were attacked. The mortality differed very notably between persons inoculated or reinoculated and those not inoculated. The mortality of the attacked in those not inoculated exceeded 52.07 per cent.; that in the inoculated, 35.55 per cent.; that in the reinoculated, 16.36 per cent.

(18) Of the 16,000 inhabitants which, according to the official census, the city contains, 11,050 submitted themselves to the action of the prophylactic method of Dr. Ferrán. It can be stated as very certain that 70 per cent. of them belonged to the poorer classes, which with very rare exceptions furnished the contingent of the epidemic. The practice of inoculation began on the 25th of April, and on the 4th of May there were already 5,000 inoculated. On the 26th of the latter month there existed 7,043 inoculated for the first time, and 4,116 reinoculated or inoculated for the second time. On the 17th they numbered 8,874 inoculated and 5,210 reinoculated. On the 30th of June the number was 2,642 inoculated and 6,884 reinoculated. On the 15th of July, when the inoculation ceased, there existed 2,220 inoculated one time, and 8,830 reinoculated.

These data being stated, I have now to describe the pathological phenomena produced by the action of this prophylactic measure in those who submitted to it. On account of the large numbers, I have thought it convenient to divide them into three groups, according to the nature and intensity of the phenomena experienced.

In the first group, limited to 3 per cent. of those inoculated, only local phenomena were perceptible, limited to a sensation of infrequent, peculiar, contusive pain, which, beginning within four hours at the point of hypodermic injection, continued to increase until, in twenty-four hours, it became so troublesome that the difficulty of moving the extremity was very marked. At the same time the skin appeared more or less infected and reddened at the point

of puncture, and there was a slight doughiness of the subcutaneous cellular tissue. These phenomena, after becoming more or less accentuated, lasted twenty-four or thirty hours in some cases, and disappeared spontaneously not later than sixty hours.

In the second group, the largest, which includes 95 per cent., the individuals inoculated, besides suffering the local symptoms above described, experienced reactive phenomena more or less intense, which, in the immense majority of cases, began with a severe chill of short duration, which stage continued and was accompanied by cephalalgia more or less severe, general weariness, some fever, and marked depression of strength. This access of fever terminated in twenty-four to thirty-six hours with a copious diaphoresis.

The third group, which is the most limited, comprises only 2 per cent. of the inoculated, viz, those who besides the local symptoms and the secondary reaction suffered functional disturbances of the digestive canal, extremely marked in some cases. These disturbances varied in degree from a simple diarrhoea to a real experimental cholera. In this group also the symptoms terminated in thirty to forty hours, without, in any case, requiring medical assistance. It is a fact worthy of note that among the large number of persons inoculated, there developed only sixteen benign phlegmons, which terminated happily without any of them presenting the slightest septic character. It is also noteworthy that although a considerable number of pregnant women, even as far gone as the seventh month of gestation, submitted themselves to this prophylactic method, not one of them suffered an abortion, or any other trouble. Furthermore, in a number of cases, I have most distinctly observed a genuine experimental cholera experienced by infants at the breast, twenty-four hours after their mothers had been inoculated.

Special mention should also be made of observations relative to modifications of the course and intensity of the cholera in persons who had been previously subjected to the Ferrán method. Although the statistics relating to the mortality are eloquent and tend to demonstrate the prophylactic efficacy of the inoculation, I must refer to those relating to the number of attacks in individuals not inoculated, in those inoculated once, and in those reinoculated, in proportion to the inhabitants of the city. The result is that of the non-inoculated, there were 9.02 per cent. attacked; among the once inoculated, there were 2.02 per cent. attacked; and among the reinoculated, there were only 0.72 per cent. attacked. In the immense majority of the two latter, especially among the reinoculated, the intensity and course of the disease were very perceptibly and profoundly modified, for the disease ran through the periods which characterize it with great rapidity, presenting at the same time a notable attenuation of its symptomatic manifestations. But a large number of the reinoculated might be regarded as true typical cases which have presented admirable pictures of attenuated cholera. In them the disease has begun with energy and presented the whole series of symptoms, even to algidity, but the reaction has been easy and free, and everything has terminated happily in the short space of three to eight days.

(19) I do not personally know of any individual who, during this epidemic, has suffered a second or third attack of cholera; and a similar answer would be given by all my colleagues of this city.

JOSÉ ESTRUCH.

ALCIRA, *February 3, 1886.*

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REPLY FROM THE SUBDELEGATION OF MEDICINE IN CARTAGENA, BY DR. DON LEOPD. CANDIDO,  
TO INTERROGATORIES CONCERNING CHOLERA IN THAT CITY.

Asiatic cholera made its appearance in Cartagena on the 11th of June, 1885, in the person of a sick woman from Valencia. On the 13th another case appeared in the city in a prostitute who came from Murcia. The latter case was followed by some others among washerwomen and soldiers, and the disease gradually spread throughout the whole city, forming isolated foci, in spite of the fact that the city was surrounded by a cordon which prevented ingress absolutely to every person after the 13th.

In Cartagena there is no river, and the supply of water is obtained from springs located on the side of a small mountain which is crowned by the castle of San Julian (which commands



the city and harbor), about two hundred meters above the level of the sea, and is carried in water casks to wells scattered through the city.

There are no sewers of any kind in this city, and the cholera spread most extensively in those quarters where the poor dwell, some of these quarters occupying the tops of hills.

The thermometer oscillated between  $34.5^{\circ}$  and  $22.3^{\circ}$  C. The maximum barometric pressure was 65.6; the minimum, 54.2 C. M. The hygrometric condition varied between .95 and .45. The prevailing wind at the commencement of the epidemic was northwest.

At the termination of the epidemic the temperature was: maximum,  $37.9^{\circ}$ ; minimum,  $16.2^{\circ}$  C; the barometer was 764.1 to 751.2; the hygrometric maximum was .30 and the minimum .48; the prevailing wind was south.

It rained seventeen days in the month of August, that is, during half of the epidemic, and the cholera spread with greater intensity after the rain.

The daily progress and extension of the epidemic are included in the statistics furnished. (Very copious details in the form of tables, showing the daily attacks and deaths per street, are given, but we omit their reproduction here.)

None of the methods of curative treatment merit any consideration as a specific in combating cholera. Hypodermic injections of the bisulphate of quinia, of morphia, and of pilocarpine have alone given any visible results in alleviating the symptoms by favoring reaction, checking vomiting, and shortening the period of algidity.

Of 368 who were inoculated with the virus of Dr. Ferrán only 5 died, and these had not been reinoculated.

The mortuary statistics of the previous five years during the four months which correspond to those during which in 1885 we had the cholera, give a contingent of 86 per cent. of the latter year.

There is no report that any person has had a recurrent attack of cholera, and since the 30th of September there has been neither a suspicious case nor one of confirmed cholera.

Up to the present no precaution has been taken to prevent the recurrence of cholera here next year.

DR. LEOPD. CANDIDO,  
*The Subdelegate of Medicine.*

CARTAGENA, *January 30, 1886.*

#### REPLY TO INTERROGATORIES CONCERNING CHOLERA IN FUENTE ENCARROZ, IN THE JUDICIAL DISTRICT OF GANDIA, AND PROVINCE OF VALENCIA.

(1) This village was invaded by cholera on the 3d of May, the four attacks on that day occurring in agricultural laborers who had been, on the preceding days, working in the neighboring villages of Alqueria de la Condesa and Bellreguart, in which cholera existed at that time.

(2) From the 3d of May suspicious cases were occurring, some of which constituted foci from which the cholera slowly spread until it assumed a really epidemic form from the 21st of June to the 11th of July, when the visitation ended.

(3) The disease spread gradually after its appearance on the 3d of May up to the 20th of June. From the 21st of June to the 11th of July the march of the epidemic was rapid, the period of apogee lasting ten days, viz, from the 21st of June to the 1st of July, and the period of descent being eleven days.

(4) The cholera in this town first spread from the four foci or centres constituted by the first cases, and subsequently from others located at separate points in houses situated at different levels above the sea, although they all were lacking in good hygienic conditions.

(5 and 6). During the months of March and April, there was several times a general cleaning of all the streets and public squares of the town, domiciliary visits for the removal of the causes of unhealthiness, an endeavor to ventilate the houses and to whitewash them inside and outside with a mixture of lime and chloride of lime, and an effort to remove from the courts the excrementitious matters whose emanations might be prejudicial.

The public fountains were cleaned daily and their water was allowed to flow more freely; the public lavatories were objects of special care, and were cleaned several times every week in order that their water should be always pure. Especial care was also given to the prison and to the public slaughter house.

For the houses in which unfortunately cholera appeared, the clothing of the healthy was washed, as usual, in the public lavatory within the town, whilst that of the sick was boiled, and after remaining some hours in a solution of chloride of lime, was washed in the irrigation canal which passes near the town.

There was a daily inspection by a permanent health commission of food offered for public consumption, and the sale of unripe fruits and vegetables not in good condition was prohibited.

Fumigations by a brigade of four men were performed in the houses of the sick and in the streets most infected.

As a hygienic measure, and in order to avoid sorrowful and prejudicial impressions in the sick, as in the well, the tolling of the bells either for religious purposes or for announcement of deaths, was prohibited.

It was ordered that corpses should be kept in the house only a short time, that they should be sprinkled with a solution of chloride of lime from the moment death occurred, and that they should be removed to the cemetery at dawn, midday, or evening, and buried within six or eight hours after death. The laws of sepulture required that the grave have five feet of depth, and in case of very numerous deaths, that trenches be opened for the inhumation of several cadavers at a time, especial care being taken in such cases that there be a covering of lime over the latter.

The houses of the sick were isolated at first, and in all cases fumigations were practiced. Several houses in the country were designated as lazarettos, and others as houses of observation and inspection of travelers.

These were the principal measures adopted during the months of March and April.

On the 14th of May the civil government of the province surrounded this town with a sanitary cordon, and isolated it from the healthy villages which were left in communication with other villages already at the time infected, such as Rafelcofer, Alqueria de la Condesa, Bellreguart, Beniarjó, Almocías. The cordon was inefficient, for it was so easy to pass in spite of it that it may be said that all the villages, both healthy and infected, were in constant communication with each other.

(7) All the inhabitants use drinking water from a fountain which is supplied from a spring within the village. The water is of good quality.

(9) The water used for irrigation proceeds from the river Serpis, or from the Alcoy, a river which passes by other villages before entering the *huerta* of Gandia. The irrigation canal which passes near the village of Fuente receives water from the town of Villalonga, one and a half hours distant, and traverses the village of Patriés, one-half hour distant. When the cholera broke out in Fuente Encarroz, the epidemic did not exist either in Patriés or in Villalonga, or in the villages by which the river Serpis flows.

(12) The points most affected by the epidemic were the houses situated to the southwest, and particularly in San Antonio ward, where they are generally damp and badly ventilated, and the courts can not give free exit to the water on account of the lay of the ground, there being no public sewers either in this ward or in the rest of the town.

(13) The town of Fuente Encarroz is situated at the foot of a hill, distant  $1\frac{1}{2}$  hours from the Mediterranean Sea, at 41 meters above its level. The town rests upon a triassic formation. Its surrounding lands are in greater part of red clay; its mountains are of limestone, with a triassic and jurassic base. To the northeast and southeast the town is overlooked by mountains of considerable elevation. The soil of its *huertas* is fertile, the vegetation is exuberant; the climate is mild, the heat of summer is little above  $25^{\circ}$  .C, and is tempered by the sea breezes; in winter it is rarely cold; the prevailing winds are from the west, east, and northwest, and in many years from the north, southwest, and southeast.

From the month of September, 1884, rainy weather was almost continuous, as throughout



the whole province of Valencia. The winter was rough, with frequent rain and snow, the latter heretofore unknown in this town, and this weather continued until spring, constantly keeping the soil damp. As a consequence of this weather, of the constant dampness, and of the failure of wages for the poor, the inhabitants of this town were in a very bad hygienic condition on account of the scarcity and bad quality of the food for many months.

Under these unfavorable conditions the agricultural labor began in the spring, and many laborers went out to work in the neighboring villages of Bellreguart and Alqueria de la Condesa, where there were already cases of cholera. A few days after this the epidemic began in this town, on the 3d of May, as already stated, among the laborers who had frequented the infected villages.

During the months of May and June the weather had improved and the temperature returned to its normal. On the 18th of June there was a heavy rain-fall, which lasted the whole day with variations of temperature, followed by two days of heat unusual for the season, as the thermometer marked 30° C. in the shade; but no increase in the number of attacks was noticed on that day or on the two following. From the 22d until the end of June, the attacks were so numerous as to constitute this the period of apogee or greatest height of the epidemic, in which, indeed, the majority of the attacks and deaths occurred.

The epidemic was extinguished on the 11th of July. The state of the atmosphere presented nothing unusual to the season, except that the heat of the summer of 1885 exceeded by many degrees that previously known, for it reached 40° in the shade on the 12th of August.

With the hygienic measures which were adopted and vigorously executed from a date prior to the appearance of the epidemic until long after its extinguishment, the condition of the town much improved, and this improvement has continued up to the present.

(14) The cholera lasted seventy days in this town, and there were few of these days on which there were no attacks or deaths. The period of increase was forty-eight days; that of apogee ten days, and that of descent eleven days.

*Table showing the daily course of the epidemic.*

Date.	Attacks.	Deaths.	Date.	Attacks.	Deaths.	Date.	Attacks.	Deaths.	Date.	Attacks.	Deaths.
May 3	4	1	May 21	3	1	June 8		1	June 26	9	7
4	1	1	22		1	9	1	1	27	4	
5	2	1	23			10	1	1	28	3	2
6	3	3	24	3	2	11	4		29	11	2
7			25	3	1	12	2		30	6	2
8			26	3	1	13	1		July 1	4	5
9			27	2	1	14			2	2	4
10	1		28	2	1	15	3		3	2	1
11			29	2	1	16	1	1	4		3
12	2		30	1	1	17		1	5	2	
13	1	1	31	3	1	18			6	3	3
14		1	June 1	4		19	3		7		2
15	4		2	3		20	3		8		
16	4	1	3	2		21	13	2	9	2	2
17	1	2	4	1		22	4	8	10		1
18	2		5	2		23	5	1	11	2	
19	4	2	6	3		24	11	5	Total ..	176	83
20	1		7	2	1	25	6	4			

(16) During almost the whole of the month of April, the ordinary diseases seemed to be suspended and on some days disappeared altogether, there being no patients to visit. Then began to occur some cases of diarrhoea, dysentery, colic, and a marked proportion of disorders of the stomach, which in many cases excited the suspicion that they might be so-called cholérine, or cases of sporadic cholera (*cholera nostras*?), which are not rare at this season.

(17) In the first period, or that of cholérine, when it began with a slight general malaise, accompanied by heaviness in the head, lassitude, anorexia, thirst, repugnance to solid food, etc., which at another time would not have attracted attention, we first combated this condi-

tion, which we regarded as that of incubation, by prescribing some cups of hot tea with a few spoonfuls of burnt brandy, cognac, or rum, and at the same time observing general hygienic precautions.

If the beginning of the choleric had been marked by an indigestion or a gastric disturbance, I had recourse to the evacuant method, by the employment of ipecacuanha in the dose of  $1\frac{1}{2}$  to 2 grams, or castor-oil with common marrow.

Usually the disease presented symptoms of lively colic, nausea, infrequent vomiting, frequent movements of the bowels, with a yellowish-white or a whitish, semi-transparent, inodorous fluid, holding in suspension, not the rice-like granules described by the authors, but scarce and irregular whitish flakes; the thirst was usually intense, the tongue narrow and moist, the pulse frequent or a little accelerated, and there were cramps, anuria, etc. In these cases, already attacked with a well-marked choleric, we acted with the same energy as in a confirmed case of cholera, by requiring the patient to go to bed and wrap himself up well in order to secure perspiration, permitting only an emulsion of rice alternated with small cups of infusion of tea, tilia, or chamomile, with a few spoonfuls of spiced brandy to be swallowed.

The diarrhoea was combated, *p. r. n.*, with subnitrate of bismuth in the dose of 4 to 8 grams daily, with laudanum of Sydenham, 10 to 60 and more drops daily, according to the age and condition of the patient. Having observed the good results obtained in diarrhoeas with elixir of paregoric of the French pharmacopia, I employed it also against the choleric, or, more correctly speaking, the choleraic diarrhoea, in the dose of 10 to 20 drops in sugared water, or in an infusion of chamomile every hour. The subnitrate of bismuth, laudanum, and elixir of paregoric were, in my hands, the best remedies, since neither the anticholeric drops of Lébert, nor columbo, nor rhattany, nor others which I used, gave as good results.

The vomiting which so disturbed the patients was combated generally with the anti-emetic potion of Riverio, which produced good results, for neither sulphuric ether, nor chloroform, nor opium or its preparations, behaved as well.

In the algid period, or that of concentration, during the present epidemic, the most striking symptoms were depression of temperature, a frightful lividity, darker than that which usually corresponds to the cyanosis of cholera, diarrhoea, not very persistent and sometimes even absent; irregular pulse, irregular respiration, etc.

In the dangerous period, I directed all my efforts to the exterior, using friction to the extremities and to the spine, sometimes dry, sometimes moist, with more or less stimulant materials, applying flying sinapisms in large numbers, and enveloping the patient in warm wraps.

When, in spite of these measures, the algid state became confirmed, the above-mentioned remedies were continued, but with greater energy; stimulant potions were administered internally, with acetate of ammonia, and alcoholic stimulants such as wine, rum, cognac, according to circumstances.

In some patients in whom the thirst was devouring, the vomiting almost uncontrollable, and who refused to take medicine by the mouth, good effects followed the administration of cold water alone or with a few drops of lemon juice, taken as the thirst demanded, but in moderation, and enemas of alcoholic infusions of coffee or chamomile at proper times gave good results.

We antagonized cramps by frictions with a woolen cloth, or with a mixture of oil of turpentine, one part, and two parts of camphorated alcohol. In many cases every remedy employed was useless, and the patients succumbed in this period of concentration, some of them within eight or ten hours from the beginning of the attack.

When the reaction has been incomplete and the cyanosis persisted, the pulse developed little force, the prostration continued, the anuria still marked, etc.,—in these very grave cases, the external stimulant applications were pushed energetically; coffee and alcoholics were given by the mouth or per rectum. Even in some of these cases the power of nature gained the day, and the patient recovered from his desperate situation.

When congestion of the brain followed reaction, the patient was required to remain in bed with the head elevated, and was treated by cold affusions to the head, and given acidu-



lated drinks; enolient enemas were given and revulsives applied to the extremities. If the reaction presented typhoid symptoms, the usual treatment for such a condition was employed.

(18) The anticholeric inoculations were not practiced in this town, but twenty-seven of our people were inoculated in Rafelcofer and seven were inoculated in Valencia, making a total of thirty-four. Seven were inoculated in Valencia on the 19th of May by Dr. Jaime Ferrán, as already indicated, and all were re-inoculated by the same doctor on the 26th of the same month. Those inoculated for the third time did not return to this village until after the end of the epidemic, but remained in Massanasa, a village also infected. The other four returned to this town the day following the re-inoculation and had continual intercourse with the cholera patients without experiencing the slightest indisposition during the epidemic.

The remaining twenty-seven were inoculated in Rafelcofer, a village near this town, by Dr. Arturo Ortigosa, after the method of Dr. Ferrán, on the 3d and 4th of July, or during the period of descent of the epidemic in this town. Of these only three lived in the quarter which suffered most from the epidemic.

Of the twenty-seven inoculated in Rafelcofer there were only two attacked by cholera; one, attacked in forty-four hours after the inoculation, was a young married woman twenty-seven years of age, of a lymphatic-nervous temperament, robust constitution, surrounded by good hygienic conditions which had existed from before the epidemic. A few days before the inoculation she had visited frequently and remained for several hours with a friend severely attacked with cholera. The course of the disease in this young woman was rapid, for she died in fourteen hours with the symptoms of a typical case of asphyxic cholera.

The other person was attacked ten days after the anticholeric inoculation. She was a married woman, thirty-five years of age, of lymphatic-nervous temperament, ordinary constitution, somewhat weakened by lactation and by insufficient food. She also had had intercourse with cholera patients before and after the inoculation. Although she presented a complete picture of the algid state, it was with a certain benignity, and she reacted promptly and fully. During convalescence she suffered from intestinal catarrh, from which she ultimately quite recovered.

The other twenty-five inoculated did not suffer the slightest indisposition during the remainder of the epidemic.

I have nothing to say about the harmlessness or danger or of the utility or uselessness of the procedure of Ferrán, for I have personal knowledge of a too small number, all of whom were inoculated during the decline of the epidemic, and the inoculated, although of different ages, sexes, and conditions, almost all belonged to the rich or middle class. I need more extensive personal statistics in order to express a favorable opinion concerning the procedure of Dr. J. Ferrán.

(20) I have already stated in another place that the sanitary cordon established on the 14th of May was defective, for it was not sufficiently strong. It was evaded, and the infected villages held continual intercourse with those which were healthy. The fumigations practiced in the houses of those sick with cholera frequently were not performed with the most exemplary care, but it appeared, nevertheless, that they impeded the propagation of the disease during the period of ascent.

The municipality have taken no measures to prevent the re-appearance of cholera in this town during the next summer. Up to the present nothing has been done. This is our nature. We remember Santa Barbara only when it thunders—and it must thunder loudly—yet we curse the result. This is Spanish.

(22) During the winter between 1884 and 1885 there occurred here a few isolated cases of cholera, some of which were recovered from, but the majority were fatal. Since the extinction of the recent epidemic, on the 11th of July (1885), there has been no vestige of cholera or of any disease which resembled it.

(23) The mortuary statistics since the year 1880 have been as follows: In 1880, 61 deaths; in 1881, 68 deaths; in 1882, 77 deaths; in 1883, 97 deaths; in 1884, 66 deaths; in 1885, 176 deaths.

(24) During the epidemic of 1834 there were more deaths than during the last; in that of 1854 the cholera did not cause as many deaths as in the last; in the epidemic of 1865 there

were only 34 attacks and 12 deaths; in the last invasion of 1885 there were 176 attacks and 83 deaths.

It is to be remarked that all of these 176 cases were very severe. Three-quarters of the whole population were attacked with diarrhœa—and many such attacks were really of cholera—which were cured and not entered in the statistics. On account of the large number of diarrhœal patients whom it was necessary to visit it was impossible to give proper attention to the grave cases, for I was the sole person charged with medical attendance, and I had also to visit the neighboring village of Petreis, which was also attacked by the epidemic. This excessive labor without rest, many nights without sleep, undermined greatly my physical strength.

(25) Few were the inhabitants of this town who, panic-stricken, fled on the appearance of the cholera. Only some ten persons abandoned the village in the first days of the epidemic, and they did not return until it had entirely ceased.

NOTE.—During the period of ascent of the epidemic it was observed that when the western winds prevailed there were more attacks. The latter were also more numerous on the days following fêtes, due, in my opinion, both to the excesses which on those days were committed with alcoholic beverages, and also to the assembling of a greater part of the inhabitants in the small parochial church. Fear and panic greatly favored the attacks. In children the cholera was more benign. The asphyxic attacks were all fatal.

RICHARDO. ANTONIO ESTEVE.

FUENTE ENCARROZ, *February 12, 1886.*

#### REPLY TO INTERROGATORIES CONCERNING CHOLERA IN THE CITY OF GRANADA.

Dr. Paulino Ventura Sabatie, of the city of Granada, replying to the interrogatory which I sent him, thus answers the sixth :

(6) They endeavored to isolate the first cases, although in an imperfect manner. After the epidemic developed lazarettos were established; disinfections were performed, also imperfectly. When the disease assumed alarming proportions some energy was manifested, although the disinfections were still incomplete, and the lazarettos were suppressed. The public cemetery had got into an alarming state of abandonment; hundreds of corpses remained unburied for four and six days. It was the 14th of August. At this date it is said that the deaths reached four hundred and eighty per diem. Then the service of the cemetery was improved, disinfections were increased, domiciliary assistance was organized, cholera hospitals were established, and the public hygiene was somewhat improved.

And he thus also answers the seventh :

(7) The potable water of Granada proceeds from the rivers Darro and Genil, which flow over lime and mineral deposits, and from the Fuente Grande of Alfacar, which springs from limestone. The conduits are uncovered. The water is distributed by very imperfect terracotta pipes, and its current is sometimes intermingled with that of the sewers.

#### REPLY FROM THE OFFICE OF MILITARY SUBINSPECTION OF HEALTH, DISTRICT OF GRANADA.

[STATISTICS AND REPORT UPON THE EPIDEMIC OF ASIATIC CHOLERA, WHICH PERSISTED DURING THE MONTHS OF JULY, AUGUST, SEPTEMBER, OCTOBER, AND NOVEMBER, 1885, IN THIS CAPITAL AND THROUGHOUT PARTS OF THIS DISTRICT.]

In writing this report in fulfillment of a duty imposed upon me by the circular from his excellency the Director-General of Health, dated 31st of last August, I can say but little that is new concerning Asiatic cholera, a disease which has with such frequency visited us during the present century and caused panic and desolation wherever it has appeared. This disease is, unfortunately, well known through its effects, and every physician professing the science of medicine is well acquainted with those more or less rational views of combating it with which our therapeutic arsenal is stocked. It is solely my intention to give a résumé of the last invasion of the Peninsula by cholera, the best known measures of prevention, and the



knowledge which I have acquired practically concerning the most rational and acceptable treatment up to the present, for we have no exact knowledge of the best means of combating this terrible disease.

The disease which appeared in the city of Toulon, imported from Egypt, where it broke out during the year 1883, or brought from Tonquin by French ships, was not slow to show itself in Marseilles, Naples, and various other ports of France and Italy. It was at length transmitted to Spain (in 1884) and appeared in villages of the province of Alicante, such as Beniopa, Novelda, Elche, Monforte, etc., in which it developed with more vehemence. It was encountered also, although with less intensity, in some of the villages of Valencia and Cataluña. Sanitary measures of isolation and disinfection were taken at that time, and the disease as an epidemic was extinguished in those localities, or at least became latent, soon again to appear in the month of March (1885) and be spread to different villages of the province of Valencia, as is thought, by the laborers engaged in the culture of rice. They follow this occupation, whilst living under miserable conditions, which, according to Drs. Koch and Pettenkofer, are so favorable for the germination and development of the comma bacillus. The fact that the epidemic was introduced into the country one year, became latent during the winter months, again to revive and spread over the whole of the Spanish Peninsula in the spring, is but a repetition of what has been experienced in former visitations of cholera. We see it appear in March of this year (1885) in Játiva, in April in Alcira, and successively in different villages of the province of Valencia. The epidemic then took renewed activity and extended to the city of Murcia and its surrounding country, to Aranjuez and Saragossa, and on the 13th of July it made its appearance with a few cases in Granada.

I do not consider it difficult to point out the cause of its appearance in this capital. This province is adjacent to that of Murcia and Almeria. Moreover the sanitary measures which it was possible to put in practice (obedient to superior orders) for the isolation and disinfection of the persons and effects of travelers proceeding from infected points were insufficient. Besides the arrival in this city of emigrants and agricultural laborers from those provinces was well known, the place of arrival being that where the first cases appeared in this district—Cortijo del Posito of Ubeda. The same may be said of Baeza. The epidemic did not delay many days in making its appearance in this capital. One of the first attacks was in the case of a woman proceeding from the fields; she dwelt in one of the houses of Albaicin and was taken to the Hospital of San Juan de Dios and died in a few hours. Besides these first attacks there was also on the 19th of July an orderly of the captain-general who had been in communication with a family recently arrived from Valencia, living in a house near the captain-general in which other individuals were also attacked. The germs of cholera were favored by the climatological and topographic conditions of this locality, by the elevated temperature and the hydrographic condition of the soil, by the large numbers of the poor class located usually in contracted quarters and living under the most miserable hygienic conditions possible. And the inactivity of the civil authorities respecting the adoption of measures to avoid the propagation of the disease caused the cholera to spread more widely and invade more rapidly the whole of the city than I believe it has done in other places, gaining many victims and occasioning panic and desolation in many families, notwithstanding the emigration of some of the well-to-do.

In spite of good hygienic regulations which had already been adopted not only relative to the military quarters, but also to the individuals themselves, the garrison was nevertheless attacked by the disease and was one of the points where the epidemic began, the first cases occurring in the detachment quartered with the captain-general. According to the regulations already established, disinfection of beds and effects of the individuals and cleansing of the locality were at once resorted to, but other attacks in the same building not ceasing to occur it became necessary to discharge a company quartered there as well as the cavalry escort and a numerous personnel of orderlies and clerks. Finally the governor-general was attacked and died in a few hours, a victim of the epidemic. These facts demonstrated the existence of a focus in that edifice where such a large number of individuals resided, and I recommended to his excellency the captain-general the urgency of its complete evacuation in order to secure its disinfection.

The first cases were at once taken to the provisional hospital established in the Plaza de Toros (bull-ring), where it was necessary to locate it, for there was no other place disposable. The establishment of this hospital had been provided for by superior military authority upon the appearance of cholera in Spain during the previous year, and the proprietor gave the use of this place gratis. The necessary division of the arena and amphitheater into apartments and the construction of a roof were supervised by the corps of engineers.

Fifty beds were at once provided, the number subsequently reaching upwards of one hundred, with the necessary furniture in the circular gallery, which exists beneath the upper tiers, besides a hall for the officers of the hospital, a store-room, a kitchen, a room for disinfection, a room for nurses and attendants, a hall for convalescents, a drug store, quarters for the physicians and for the guard, a mortuary, a lavatory. The hospital was further arranged so that there was a hall for the officers, etc. A sufficient corps of attendants, servants for the cleaning and continuous disinfection of clothing, a corps for attention to the removal and burial of the dead were organized, an official druggist and chaplains were appointed. An executive department, under the direction of the chief, was established, which, together with three medical officers and a director of the military hospital, constituted the government of this extemporized hospital. His excellency the director-general, at the time of his visit of inspection, on the 8th of August, when the epidemic was at its height, gave further directions concerning its organization. I had the honor during the visit of his excellency the minister of the interior to the hospitals to receive his commendation concerning the good service and assistance which the sick in this provisional hospital received, notwithstanding its inconvenient location in an establishment of this sort.

At the same time a department for convalescents was established, in order that the cured might not be transferred at once to their own quarters, and thereby possibly transmit the disease to their comrades. The palace of Charles V, in the Alhambra, was the place originally destined for this use, but in a few days the location of this department was transferred to the Carthusian Convent, because that building possessed better hygienic conditions. In the latter place they remained under the supervision of an officer of the army until a physician appointed to visit them daily, morning and evening, might consider them in a fit condition to be removed to their quarters.

The foregoing having been premised concerning the appearance of epidemic cholera in this district, as also in this capital, and the hygienic measures recommended and the establishment of the provisional hospital having been alluded to, I shall now proceed to discuss the prophylactic measures which I deem most efficacious, and which governments should adopt in order to avoid the transmission of the disease from one locality to another.

Well established as it is that the disease is eminently contagious, that it is transported by individuals, baggage, and other effects, isolation by lazarettos, quarantines, and sanitary cordons are the first measures which should be made use of, such as were adopted the previous year in villages of the provinces of Valencia and Alacante, with the result of extinguishing, or at least staying, the epidemic until its re-appearance in the spring by means of agencies already mentioned. But considerations which it is not my duty to criticise caused those very efficacious measures to be forgotten and others to be adopted which, although they might give good results, did not radically combat the contagion, as the facts have shown. They were more difficult of enforcement by reason of the continuous disinfection and the isolation of persons and places necessary, and the danger of contagion was greatly enhanced by any carelessness whatever. At any rate, under the enforcement of the latter measures the greater part of the villages suffered the disastrous effects of the epidemic. All those measures which sanitary laws dictate should be put in practice, the perfection of public hygiene everywhere, would be the basis of my action, supporting myself by what the distinguished hygienist, Monlau, has said: "Given a village which possesses all the desirable conditions for good health, we will be responsible for the damage which an imported contagion causes, because the pabulum and conditions necessary for the exercise of its injurious action will not be found." But since the actual state of the public health is—in the majority, not to say in all, of the villages—very far



from being in such a state of perfection, very efficient and rigorous measures are necessary to effect the isolation of a contagious and dreaded disease, although they are always considered prejudicial, as well by those who are the subjects of isolation by means of cordons, etc., as also by those of the contrary opinion, on account of the paralysis which is produced in all kinds of business through the fear which is occasioned and the privations which large numbers of individuals suffer; this being the most painful injury to which all are exposed.

I have considered the etiology, prophylaxis, and precautions which, according to the reports of physicians, have been observed in all the military edifices as also in the other parts of the district which have been more or less intensely affected by the epidemic. Concerning the symptoms of the disease, I have little to add to the exposition of the classic authors who have described them. I shall only mention the forms most frequently presented—mucous and serous diarrhea, with the later symptom, which attracts attention to this affection, namely cramp. Cramps did not always find their location in the extremities. There were numerous cases in the hospitals of Granada in which the cramps were located in the thoracic region, and some in which they were confined to the central organs. In these cases the asphyxic stage rapidly appeared unless this terrible symptom were combated, and paralysis of the heart thus avoided.

Complications of a typhoid nature were quite numerous. A comatose condition and difficulties of digestion carried off many patients. I have had occasion to observe this in my practice during other epidemics.

Abscesses of the parotid gland, petechial eruptions, and other complications have had but little development. Not a twentieth part of the patients have experienced them, and there was only one death among these. The so-called “fulminant” forms, followed by death in a few hours, were more frequent in the beginning of the epidemic, and also during the period of its increase; whilst they were less frequent during the decrease, a circumstance which I have also observed in other epidemics of this kind.

The action of the morbid agent which produces these pathological forms I consider to be malignant. The pernicious effects upon our organism fall upon the nervous system of the trisplanchnic, which governs the action of the chief organs of life, such as the heart and lungs. In its nature essentially deleterious, it immediately attacks these principal centers of the system and threatens life. Nature finds itself deprived of sufficient reactive power to overcome the disease and to remedy the irregularity of the normal functions, or in other words, the law of conservation is overthrown and the forces are powerless to regulate the economy. This is what we know and see of the malignity of Asiatic cholera when it runs its course with rapidity, and it justifies us in regarding it as an ataxo-adyynamic condition, followed on the one hand by resolution, and on the other by a collapse which is sufficient to occasion death.

The treatment generally employed in the hospital of the Plaza de Toros, as also in other parts of this district, has been symptomatic, or so-called rational, for up to the present we have no specific with which to combat the disease. In the first period, and also in the second, the opiates and aromatic tinctures and infusions, with and without vegetable and mineral astringents, have been followed by happy results. Among the latter we would recommend bismuth in the form of subnitrate or salicylate. These measures were conjoined with diaphoretic drinks in small doses and revulsives to the extremities as also to the epigastrium when vomiting has been persistent. The latter symptom has been combated during the second period with ice in the stomach, hypodermic injections of concentrated solutions of hydrate of chloral or of the chloride of morphia or of ether, or by the application of heat to the surface in order to procure reaction before the patient passed into the asphyxic or typhoid stage. For the latter condition many employed tonics and diffusible stimulants, such as extract of quinia, etc., alternating with anti-spasmodic potions in small doses, and also with spoonfuls of rich wine, to which was added later some broth, if the condition of the patient allowed. I might mention that with this treatment I have cured a few patients in this last stage, and have had the pleasure to observe during my visits at this hospital the physicians charged with the care of the cholera patients follow it with good results. A general warm bath has also been used in this period, but without obtaining favorable results. The persistent and very troublesome

anuria of this disease has disappeared in a number of grave cases after frequent frictions of both renal regions with a preparation, either oleaginous or alcoholic, of tincture of cantharidin, of castoreum and ether. They have also been employed, according to circumstances, in the typhoid conditions of grave character, this complication in the majority of cases being usually very slight when this treatment was employed from the first or second period of the disease.

Pilocarpine has been administered in hypodermic injections for its diaphoretic effects, but without desirable results. It remains to make mention of the administration of ether by the rectum, the treatment initiated by a professor of the University of Granada, Dr. Godoy, and put into practice in the provisional hospital by the attendant physicians. The object of this treatment, according to the theory enunciated by the second physician, Dr. Granizó, in his pamphlet, is to kill the bacillus or produce anæsthesia of it, or it acts as a sedative to the acute processes of the disease. In order to prove, first, that it is a germicide it would be advisable to try the action of ether upon the micro-organism obtained from the dejecta and observe the influence which it exercises, in order to obtain fixed data concerning the *modus operandi* of this therapeutic measure.

The statistics of the results obtained in the hospital of the Plaza de Toros were not so complete as was to be desired. They relate solely to a few patients in the second period, or that of serous diarrhœa, which I had occasion to note in my visits of inspection; they do not concern the third period, or that of asphyxia. From them it is to be deduced that the administration of ether in this form is a new remedy which in certain cases may give good results; meanwhile, we have no scientific knowledge of the true action of ether upon the bacillus. We have, however, other means of administering this most useful medicament, now by the rectum (with the necessary apparatus which preserves a sufficient temperature for its entrance into the intestinal canal), now by the digestive apparatus, when circumstances permit it, and again by means of the hypodermic syringe, a mode of administration not subject to the inconvenience which in some cases are met with in the rectal administration on account of the pain which is produced and the complications which occur. When it is necessary to administer the ether at short intervals in order to secure its constant action upon the intestinal tube, which was the occasion of its use in the hospital of the Plaza de Toros, some good results are to be obtained.

No autopsies were performed nor were any microscopical or pathological observations or studies made because it would not have been possible to establish a histological laboratory, there being no microscope at our disposal.

*Résumé of military cholera statistics in the district of Granada,*

Localities.	Attacks.	Deaths.	Cured.
Granada :			
Officers .....	38	13	25
Men .....	228	59	169
Jaen :			
Officers .....	5	2	3
Men .....	29	4	25
Almería :			
Officers .....	11	3	8
Men .....	12	3	9
Total of the district :			
Officers .....	54	18	36
Men .....	269	66	203
Grand total .....	323	84	239

NOTE.—It is impossible to state the number of men existing in garrisons of the district, for we do not have the necessary data.

RAFAEL MEJIA,  
*The Director Subinspector.*

GRANADA, December 30, 1885.



## REPLIES OF THE CHIEF DIRECTOR OF THE BOARD OF HEALTH OF THE CITY OF GRANADA TO INTERROGATORIES CONCERNING CHOLERA.

(1) This city was invaded on the 11th of July, 1885, the first case appearing in Cocheras street, No. 13. On the 12th there was no attack; on the 13th there were two; on the 17th, three; and then the numbers increased in a very rapid manner. It is supposed that the importation of the disease was due to laborers from Murcia, at that time infected, who came to assist in harvesting.

(2) On account of the rapidity with which the disease developed, the epidemic began in our city within a very few days from the above mentioned date.

(3) The propagation of the disease was gradually rapid, reaching its maximum intensity on the 19th of August, at which date it began to decrease.

(4) The cholera was propagated from various centers of infection, which were located at the commencement in the Captain-Generalcy, in Sta. Ana street, in the Carrera de Darro, and in the neighborhood of Merced quarter; but after the first days all parts of the city were invaded.

(5) During the summer of 1884 "stations for observation" and disinfection had been established on the principal roads for travelers and merchandise proceeding from infected places. In the summer of 1885 these precautions were redoubled. There were established, besides the above mentioned, three lazarettos where travelers from infected places underwent quarantine, and if the place from which they came were not certified by documents the quarantine was extended three to five days, as their arrival was more or less suspicious. Microscopic examinations of the public drinking water, as well as chemical analyses, were made every three days. Visits of inspection were made for the purpose of improving the hygienic conditions of the outer wards, prisons, inns, hotels, caffés, boarding houses, and inhabitants. Fumigations were practiced in all places which might become foci. Pits were ordered to be constructed in the wards which contained no sewers, and deposits of excrement, old rags, pigs, etc., were ordered to be removed outside of the city.

A special service was organized; the city was divided into districts and a physician assigned to each; a corps was provided for the daily examination of the markets, the depots, and the shops; a post was established at the entrance of the Municipal Hall, where the inhabitants might deposit their notices and demands; subscriptions were started in aid of the poor; printed sheets containing hygienic advice concerning the means of prevention of the disease, as well as the mode of treatment of the first symptoms in case of an attack, were distributed among the inhabitants; to limit as much as possible the great danger of our people, guards were ordered to watch the entrances to the city; a special hospital was established, whose installation was opposed by the populace; parochial boards were organized and expected to suggest to the municipality the hygienic improvements which in their opinion were indispensable; orders were enacted requiring physicians with private patients to daily report of the sick whom they attend.

(6) The first cases having occurred, isolation of the dwellings proceeded whilst personal assistance was rendered to the sick, and the physician was obliged to give frequent reports of the incidents through which the disease was passing. (This was done for the first six days of the attack.) The disease having ended, generally by death in the first cases, the house was vacated, the clothing and furniture burned, and physicians of the municipal chemical department fumigated and disinfected the latrines, and in case of necessity closed the house. Nevertheless, the epidemic developed, and then physicians were assigned in sufficient number for service everywhere; at the same time a corresponding pharmaceutical service was provided, by whom the poor were supplied according to contract arranged by the municipality. Various corps of men were appointed for the transportation of cadavers, and vehicles were ordered to be built appropriate for this purpose. Large trenches were dug in the cemetery, in which the corpses were covered with lime. The poor were provided with food and money, and each parochial board directed the fumigation of the houses invaded in its respective district. All

of these measures, and that of closing the public schools besides, were adopted on the 23d of July. Later on, four cholera hospitals were established in the outer portions of the city, and these public establishments were supplied with nurses. The above-mentioned parochial boards were furnished with Palastros cylinders for the disinfection of the clothing, and with materials for burning disinfectant substances in the public streets.

(7) The city is supplied with water from the rivers Genil and Darro, the canal Aynadamar and the reservoirs (or immense earthen jars) of the Alhambra, besides springs within the Alhambra called the New Fountains of the Avellano. The distribution of the water is by means of terra-cotta pipes, all of them in very bad condition, not only by reason of their permeability but also because they run beside the sewers. All the houses of the city are supplied with this water.

(8) There are villages near one of the rivers which supply this city which were attacked by the epidemic before the invasion of Granada, one of these villages being Guadix, 5 kilometers distant. The fall of the river is very small and the water has consequently a very slow current.

(9) What has been said relative to the public supply of drinking water is applicable to that used for irrigation.

(10) The public sewerage of Granada is the worst of its kind, and there are districts in which even this is entirely absent, whilst the filth and excrement are thrown into the court yards or into the public streets.

(11) On account of the intensity and great extent of the epidemic it was impossible to appreciate the relation which might have existed between the propagation of the cholera and either the supply of drinking water or the public sewerage.

(12) The parts of the city of Granada which suffered most by cholera were the parishes of S. Alfonso, S. José, Santa Ana, and S. Cecilió, localities in which the poorer classes predominated and under the worst hygienic conditions. In the majority of these districts there was no system of sewerage.

(13) I was unable to observe anything during the epidemic respecting the influence which meteorological and telluric conditions might have upon the course and propagation of the disease.

(14) The following table indicates the daily progress of the cholera (exclusive of attacks and deaths in the Cholera Hospital of S. Lázaro).

The figures relate solely to the attacks and deaths in our city.

Date.	Attacks.	Deaths.	Date.	Attacks.	Deaths.	Date.	Attacks.	Deaths.	Date.	Attacks.	Deaths.
July 13.	1	1	July 30	104	53	Aug. 16	295	148	Sept. 2	24	12
14	.....	.....	31	106	59	17	318	143	3	20	7
15	.....	.....	Aug. 1	129	69	18	272	125	4	15	7
16	.....	.....	2	129	59	19	245	116	5	17	10
17	1	1	3	165	74	20	143	104	6	11	1
18	.....	.....	4	183	68	21	189	82	7	7	6
19	1	1	5	201	92	22	158	68	8	4	1
20	3	3	6	243	117	23	156	56	9	4	1
21	5	5	7	266	110	24	127	61	10	6	2
22	12	12	8	296	106	25	101	50	11	7	2
23	20	11	9	313	169	26	103	34	12	11	3
24	29	12	10	304	142	27	78	32	13	1	.....
25	66	29	11	291	122	28	57	23	14	3	1
26	42	20	12	334	134	29	41	18	15	2	1
27	58	25	13	410	181	30	45	25	Total ..	7,011	3,254
28	73	39	14	332	170	31	36	21			
29	59	53	15	310	148	Sept. 1	31	9			

It could not be determined with entire certainty if the preventive and repressive measures which were enforced had any direct influence upon the decrease of the epidemic, for when the attempts to combat the disease were most energetic the epidemic had already been falling for several days.



(16) In this locality, especially at the beginning of summer, colics, with a choleriform character, are frequent, and this renders it quite difficult to diagnose the first attack of cholera—a difficulty of which Granada furnished many examples.

(17) Since the commencement of the epidemic the physicians have sought to discover the most efficacious treatment for cholera. Without entering into details, it may be said that the most successful, and at the same time most constantly employed, has been that advised by Dr. Tunisi [of Italy].

The administration of ether vapor *per rectum* has also been employed with benefit, a procedure devised and put into practice by Dr. Godoy, of this faculty of medicine. But the epidemic period had already passed at the time rectal etherizations were employed, and, notwithstanding the rationality of the method, we therefore lack data of a practical nature corroborative of the observations of Dr. Godoy.

It is noteworthy that the gravity of the attacks ran parallel with the course of the epidemic in such a manner that at its commencement nearly all the patients died; in the stationary period, more than half recovered; whilst during the period of decline almost all recovered. Before concluding the reply to this question I will state that the medicine was administered to the immense majority of the cholera patients by means of hypodermic injections.

(18) As soon as the news reached Granada of the proximity of the cholera—in view of the work which Dr. Ferrán had accomplished in Valencia—the provincial legislature commissioned a member of the medical faculty of this city—Dr. Eduardo Garcia Sola—to visit the points where Dr. Ferrán had performed his experiments, for the purpose of reporting his views concerning the scientific as well as the practical value of the so-called preventive inoculations. His conclusion was that they should not be practiced, for, in the first place, the comma bacillus could not live in the subcutaneous cellular tissue into which it was injected; and in the second place he considered the procedure dangerous, because the slightest carelessness might give rise to inoculation of the *vibrio serpens* and the establishment of a process of septicæmia. Dr. Sola also pointed out in his conclusions that the effects of the inoculation (of Ferrán) do not present any resemblance to the clinical symptoms of cholera. In view of the conclusions of the said professor, there was no thought of employing here this procedure—the anticholeric inoculation.

(19) Many individuals are known of who have been attacked by cholera for the second time within the same epidemic period, and in all of these cases it was observed that the first attack was benign and slow, while the second was rapid and almost always fatal.

(20) As respects the results obtained from quarantine and fumigations in this city we could make no observations. (See response No. 15.)

(21) The authorities had the chief care of all that concerns sanitation of the dwellings; they ordered all deposits of objectionable materials to be made outside of the city; constantly examined into the purity of the food and beverages; created a board of health, properly organized and equipped; projected improvements in the condition of the water supply and of the sewerage; alleviated the condition of the poorer classes, by intending to establish, as a beginning, an *asylum shop*, containing the materials necessary for supply of hospitals.

(22) Since the disappearance of the epidemic, in the month of September, no case of cholera has been registered in the city.

(23) The number of interments in the public cemetery of this city during five years is as follows:

Years.	Cadavers.
1881.....	3,231
1882.....	3,342
1883.....	3,405
1884.....	2,868
1885.....	6,211
Total.....	19,057

(24) We have no scientific data upon which we can support a reason why the cholera disappeared without leaving the slightest trace.

(25) It may be said approximately that a third of the inhabitants abandoned our city during the epidemic.

Dr. SIMANCAS,

*The Chief Director of the Board of Health.*

GRANADA, *March* 10, 1886.

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REPLY OF DR. FEDERICO OLORIZ AGUILERA, OF MADRID, TO INTERROGATORIES CONCERNING CHOLERA IN GRANADA.

Dr. Federico Oloriz Aguilera, of Madrid, kindly replied to the interrogatories concerning cholera in Granada, from which I will extract the following:

“Being a native of Granada, I was in that city in the beginning of July, 1885, when cholera began to spread in the south of Spain, and I remained in my native city until the 12th of September, when there were only a very few cases per day.”

(5) Three lazarettos were established at the principal entrances of the city. But as the city is not walled and has a very extensive circumference, it was not possible to prevent immigration, and the little rigor exercised in the quarantine and inspection of travelers contributed to this result; it may, moreover, be affirmed that *efficacious* measures of isolation were not adopted. There is reason to believe that no objects or merchandise proceeding from infected places entered the city, other than some baggage of travelers after an imperfect fumigation; but, on the other hand, the small traffic with the neighboring villages, against which no precautions were adopted, continued without the least interruption.

(6) The first cases of cholera were not isolated; the disinfection of objects and dwellings was imperfect and tardy; the first serious sanitary measure was the installation of a cholera hospital, that of S. Lázaro, formerly intended for leprosy. It received patients before it was entirely ready, for all these measures were adopted with great precipitation after the appearance of the epidemic was confirmed; that is, five days after the first case.

(7) The potable water of Granada proceeds from its two rivers, the Darro and the Genil, from a fountain called Alfacar which is 6 kilometers distant from the city, and from some other less important springs. The water is conducted by terra-cotta pipes, there being many houses having special pipes and large earthen jars of drinking water. The water is raised to all the stories only exceptionally, for the immense majority of the houses in Granada are inhabited by a single family. In many houses the inhabitants use no other water than that contained in the above-mentioned large earthen jars, and which was already in them since the previous winter; nevertheless, some of these persons were attacked. Others drink only water from the cisterns of the Alhambra, which are filled during the winter, whilst still others used only boiled water. I can not affirm that these precautions were really preventive; but, in this connection, I consider it pertinent to refer to a fact which I had occasion to observe very closely.

A family, consisting of a lady, four children, a sister, a servant woman, and a coachman, drank water from a private reservoir (large earthen jar). One day, by inadvertence of the coachman, there entered into this reservoir some water from the (public) water-pipes. Before they knew of the mixing of the water all the members of the family drank it except the lady and her sister, but especially one of the daughters, a son of twelve years, and the coachman, who, to protest against his carelessness, drank of it to excess. In four days the daughter was attacked and died in thirty-five hours; a little after the son, also, who died in five days; at the same time the other two daughters fell sick, but they recovered, and the servant woman had a very severe attack; a few days later the sister of the lady was attacked; in her turn, the wife of the coachman took the disease and died. Of this family there escaped only the lady and the coachman, *i. e.*, she who had not drank of the water at all and he who had used most of it.



En résumé, the extreme diffusion of the epidemic in Granada prevents the drawing of conclusions respecting the influence of the water in each particular case.

(10) The sewerage is very imperfect. The house-drains do not prevent the mixing of the faecal matter with the water which is conducted to the earthen jars, because of their proximity and the porosity of the material of which both are formed. In some poor wards there are no sewers, but in them the dirty water runs in uncovered trenches.

(19) I saw an old woman who affirmed that she had symptoms of cholera fifteen days before I saw her again attacked with them, having apparently remained perfectly well in the interval. She also recovered from the second attack. (He relates another case of second attack in a washerwoman, who related both attacks to the doctor, he having seen neither of them.)

A music teacher had an attack of a benign character; after a month, in which he lost almost all his family, he was attacked again and died. I did not see him in this second attack, but it is almost certain that it was cholera.

ANSWERS TO THE INTERROGATORIES RELATING TO CHOLERA IN THE CITY OF MURCIA, THE CAPITAL OF THE PROVINCE OF THE SAME NAME, 1885.

MURCIA, *April 6, 1886.*

(1) Our city was not only one of those invaded during the last epidemic of cholera which has visited Spain, but it may also be reckoned among those which have felt most severely the ravages of the disease. The first case of cholera which was observed in this capital occurred on the 5th of June, 1885, in a person, of doubtful antecedents, who was admitted into the General Provincial Hospital and died in a few hours. This attack was attributed at once to the presence, in this city forty-eight hours before, of troops which had garrisoned some villages in the neighborhood of Valencia, which villages up to that time were the only ones attacked in the peninsula. These troops had left behind, in the various towns along their march (Albacete, Archena), some men attacked with cholera.

Others attributed the invasion of this city to the existence of two cases of cholera in Archena which occurred there two days before, a village of this province where there are hot springs, believing that the waters of the river Segura, into which flows the water of these springs and in which the clothing of the patients was washed, to be responsible for the transmission. We are inclined, nevertheless, to accept, as more certain, the introduction of the cholera in this city by the troops from Valencia, since, in passing the village of Archena, they left behind them the two sole cases in that place.

(2) From this date (5th of June) cases occurred frequently, first in two soldiers in the said hospital, and afterwards simultaneously in different localities of the city, so distant from each other and in such large numbers that it was impossible to explain its propagation. The disease became epidemic in the short space of six days.

(3) Its propagation, then, as above indicated, was so rapid that in the first days it spread over the whole city, there being no ward in which there was not a large number of attacks.

(4) It can not be affirmed that there existed foci or centers of infection from which the disease radiated, for from the general hospital, situated almost in the middle of the city, the disease spread in such varied directions, people being attacked in streets quite distant from the first cases without there being any persons attacked in the intermediate streets. It was impossible to follow its irregular and capricious course. As soon as the epidemic became general it was observed that in two opposite wards, one called San Juan, in the southeast, and another San Antolin, in the southwest of the city, inhabited in great part by the poor, the epidemic was most intense.

(5) The measures which were projected for the prevention of an epidemic of cholera were cordons and lazarettos, but they were not put in execution because the orders of the Government did not permit it.

(6) In order to avoid an epidemic development of cholera, as soon as the first cases were observed isolation and disinfection were proceeded with. Communication and contact of the inhabitants of the house in which the cholera was located with the other inhabitants was prevented, and large quantities of nitrous acid gas and sulphurous acid gas were generated in the interior of the dwellings.

As soon as it was seen how insufficient was the system to stay or arrest the epidemic which had already begun, on the 10th of June a general plan of assistance and disinfection was established which produced some effect in modifying the intensity of the epidemic. This service was constituted under the orders of the local board of health. Three centers were established under the name of "houses of assistance," under the direction of physicians who gave constant aid to great numbers who were suffering. In these centers were stored large quantities of disinfectants, the distribution of which was under the charge of committees, each one composed of one hundred members. One of these members accompanied the physicians and performed the disinfection of the dwelling at the same time that the patient was examined. Meanwhile others were charged with collection of the clothing and furniture of the room of the patients as soon as the latter had died, in order to burn them, sulphur being added to the fire. The cadavers were moved in a few hours after death to the cemetery, where it was necessary that they should be retained twenty-four hours before interment.

A cholera house was established, with a proper and necessary service and under good hygienic conditions. Those who voluntarily requested it and those who had no family and no physician for their assistance were taken to this hospital.

The disinfectants most commonly employed, as well as in the establishment as for general disinfection, were hyponitric acid, sulphurous acid, solution of sulphate of lime, 2 per cent. solution of carbolic acid and chloride of lime, this being used in variable quantities according to circumstances and necessity and according to the opinions of the physicians. These measures were enforced during the whole epidemic; that is, from the 10th of June to the end of September.

(7) From time immemorial no other potable water has been used for the supply of this city than that of the river Segura, it being taken directly from the river or from some of its tributary streams which at several intervals traverse the town from north to south; besides, 2 per cent. of the inhabitants use water from wells at a distance of 4 kilometers. The surrounding *huertas* and neighboring villages are supplied with this same river water.

(8) The majority of the villages situated upon the banks of the river Segura were invaded by cholera last summer, but at such different dates that no precise deduction can be drawn or affirmations be made concerning the transmission of the pathogenic agent of cholera by means of the said water; thus, while the village of Alcantarilla, situate southwest of Murcia, at a distance of 5 kilometers and upon the right bank of the said river Segura, was attacked almost simultaneously with this city, Alguaras, a village situated farther west and upon the left bank, was attacked some days afterward in the same manner. In the village of Molina, situate to the left of the river and to the north of this city, the first cases were met with in the first days of the month of July. These villages were extensively visited by the epidemic, particularly Molina where it may be said that the epidemic broke out in an extraordinary manner.

(9) The water used for public irrigation is that of the same river Segura, but many use the subsoil water, drawn from wells or pits existing in almost all the houses.

(10) The sewerage which exists here is very incomplete. It consists of small canals or sewers, which course the central streets of the town and serve only for the collection of storm water, which is conducted either to the eastern part of the surrounding *huertas*, in order to be used for irrigation, or to the river. Household sewers for dirty water are wanting, the dirty water being received in sinks constructed in the inner courts of the houses, and by reason of filtration, when they are well constructed, they do not emit emanations detrimental to health, and require to be emptied only periodically. Every ten years the solid residuum which has accumulated therein is removed.



(11) It is not possible to establish any relation of cause and effect between the introduction and propagation of cholera in this town and the distribution of water, for although isolated cases have created some such suspicions, the necessary proof is wanting.

(12) The points most affected in our population were the opposite wards, where misery and the absence of cleanliness characterized the houses and the streets, for their inhabitants belong to the poorest social classes.

(18) Anticholeric inoculations of no kind were performed in this locality.

(19) We don't personally know of any case in which an attack of cholera in the same individual has been repeated.

(24) This capital was invaded for the first time by the cholera in the year 1834, and successively in 1854, 1855, 1859, 1865, and in 1885. That is to say, every time that it has appeared in Spain.

The principal questions having been replied to, we are sorry not to be able to reply to the others for want of exact data, such as would meet with the desires of yourself and your Government. We take this opportunity to offer you our most distinguished consideration.

RAFAEL GARCIA.

EMILIO SANCHEZ GARCIA.

ANSWER OF DR. MIGUEL BAZÓ TO INTERROGATORIES CONCERNING THE CHOLERA IN THE CITY OF MURCIA.

(1) On the last days of the month of May, 1885, the cases of Asiatic cholera began in this capital. During the whole of that month there were present cases of acute diarrhoea without choleriform character, but already in the first days of the following month of June the cases of true cholera were very frequent, and on the 5th (of that month) there was a genuine epidemic of cholera.

(2) The official statistics should clearly indicate the march of the epidemic. My notes show that its rise was gradual, but very rapid, so that the epidemic was at its zenith in the first fifteen days; it remained at this height for more than fifteen days, and then the descent began, slow and gradual, but not constant, being more irregular and varied than the ascent.

(4) At the same time several cases appeared in opposite districts of the city, that is to say, within its limits, as also in the *huerta*, it being observed that propagation took place from the primitive foci in proportion as their disinfection was tardy. As to the course of the stream of water nothing definite can be said; affirmations and denials succeed each other. Archena, a village near the river Segura, noted for its specific springs of sulphurous water, and at 4 leagues from this city, was the first town of the province which had the first case of cholera. In a few days the disease made its appearance here (in Murcia), and a little afterwards, although with some irregularity of order, it broke out in the various villages which border the river Segura.

(5) Isolation of the sick and their families, burning of objects which they used, disinfection of clothing, and ventilation and cleaning of the dwellings.

(6) The fear which surprised all did not give place during the first days to puerile vaccination. The first effort was to infuse heart and courage into the inhabitants by seeking to conceal the real truth. Parochial boards were nominated on the sixth day, composed of several inhabitants with the lieutenant-mayor at their head; and with the aid of the municipality the work of public and private hygiene was formally and scientifically begun. These boards did excellent work. They collected funds from the charitable, as well in money as in useful materials; they looked after the health of the well with appropriate counsel, and aided the sick with whatever they needed. Disinfectants, prodigally distributed by the municipality, and cleaning improved the condition of the external atmosphere. They cleaned up the houses of the sick, and they burned by night and in all the streets large quantities of disinfectants.

(7) The capital has no public supply of drinking water. The inhabitants collect the water from the river Segura and let it stand in enormous earthen jars, in order that the solid material which it holds in suspension may subside. When it thus becomes clear and transparent,

it is used. We are all, therefore, under the same conditions, with the difference that the poor have fewer and poorer vessels in which to clarify the water, which is always turbid when collected, and they drink it in worse condition than do the rich. Since the cholera invaded this city almost every one boils the water before using it.

The mountains which surround this locality abound in potable water, but its transportation is difficult, and it very soon decomposes, for it carries much organic substance in suspension. Water from the numerous artesian wells for irrigation, met with in the surrounding huerta, is also used for drinking. To tell the truth, however, this water is not really artesian, but proceeds from infiltration through the soil from the River Segura. At present this subject is being examined by the municipality.

The river Luogonero passes by the important villages which are marked on the chart (not reproduced here). It is of small constant flow, but during seasons of heavy rains its volume is very great and its current is terribly strong.

Distance from Murcia to—	Kilometers.	Distance from Murcia to—	Kilometers.
Alcantarilla .....	11	Albaran .....	33
Molina .....	13	Cieza .....	39
Archena.....	23	Calsparra.....	56
Centi .....	16	Beniel and Algurias .....	16
Lorgui .....	16½	The border of the province of Alicante..	20
Villaneuva .....	24	Orihuela.....	23
Ulea.....	24	Librilla... ..	27
Ojas.....	27	Totana .....	44
Blanca .....	29	Lorca .....	68
Nicote.....	29		

The river water is used for irrigation of the cultivated fields, and it previously passes by villages along its banks which at the time of our cholera epidemic did not have cholera patients in such numbers as they existed in this capital. It was afterwards observed that in our *huerta*, which is very thickly populated, almost with as many inhabitants as the city contains, although much more scattered, the attacks were more frequent in the direction of the current of the river and in the localities which were the lowest and least ventilated, such as El Real, El Llano di Brujas, Dolores.

(10) The sewage is of small extent and empties partly into the river in the center of the city and partly into a canal or stream of water which traverses the lower part of the town and collects dirty water and rain water, discharging at the north side of the city into an irrigation canal, this water being very much in demand by the farmers on account of its usefulness to the land. There are other canals for the irrigation of the huertas and gardens, which pass through the city.

(11) I can not easily calculate.

(12) The parishes of San Juan, San Antonio, and San Andrés were most attacked. In them the poor and the filthy are numerous, and therefore there is little of hygiene in individuals, in families, or in dwellings.

(13) Clear, serene sky, with a burning sun, high temperature, calm air, abundant and exuberant vegetation, as in the fruit and vegetable season of this huerta, with a damp soil and subsoil.

(14) Varied during the first days up to 50 per cent.; afterwards, 25 per cent. or less.

(15) We can not estimate it. The disease very quickly spread through the whole population. It sustained itself in spite of every effort, and it descended slowly. The most striking effect was observed when the poor people were removed from the wards which were most attacked to barracks in the country. The families thus removed, as a rule, suffered no further attacks; the form and progress of the disease were modified beneficially.

(16) None. Here intermittent fevers are endemic, and all kinds and forms are met with, but never the choleriform. The other diseases are those common in the towns in the south of Spain.

(17) That of Tunisi—tincture of opium.



(18) Hypodermic injections with the salts of quinia; various physicians. Abandoned because inefficient. (The reporter has evidently misunderstood the question, since the replies are irrelevant.)

(19) I have seen none, but I have seen and treated many complications following lesions of the digestive apparatus, and I have had patients who, after cholera, suffered from quotidian and tertiary intermittents in houses also containing cholera patients.

(20) Without any partiality, as a Spaniard loving our own systems, it is certain that sanitary cordons and lazarettos have benefited the health of those towns which have thus defended themselves, as was proved in Sevilla and here in several towns of this province. Last year, when the disease was very near us, in Alicante and its villages, isolation protected us.

(21) To our shame and misfortune, none.

(22) None. The public health appears to be better, and we have not had the diseases of the season nor any special tendency to disease.

(23) I do not know; upwards of two hundred and thirty-eight.

(24) The medical history of this country says that whenever cholera has entered Spain, Murcia has suffered from it. The villages of this province along the coast are supposed to be immune, and the cause of this is attributed to the iodine of the atmosphere.

(25) I can not definitely say, since many families upon finding themselves uncomfortably fixed in the country again took refuge in the city; but some calculate that a third part of the population fled, others that a fourth part abandoned the place.

It is to be added that of the families which returned in the months of September and October, many fell sick of cholera, almost all of these attacks being fatal, at least those which I saw, and those who escaped an attack had diarrhoeas and disorders of the digestive functions.

The undersigned also experienced upon days during the epidemic passing disturbances of the following form:

Being in my usual state of good health, and without any change of regimen except greater precautions and more careful hygienic habits, whilst making a visit I would experience an epigastric restlessness, nausea, slight vertigo, coldness in the legs, tension in the thighs, and a little cold sweat over the whole body. I would come home, take *tilfome* infusion, and cover myself up well. I would then experience an expansion of the whole arterial circulation from the center to the periphery, increased heat and a very copious perspiration, and in two hours would return to my sorrowful visits.

I think that that has but little significance, but whilst I am relating to you my impressions, why should I omit my own feelings?

I can give you more details respecting the parish in which I live, with the object of furnishing you the data.

From the 10th of June, when the epidemic began in this ward, to the 29th of September of 1885, upon which occurred the last case, there were three hundred and eighteen attacks and one hundred and forty deaths, classified in the following manner:

Attacks :		Deaths :	
Adults.....	251	Adults.....	105
Children.....	57	Children.....	35
Male.....	136	Male.....	57
Female.....	172	Female.....	83

Hours of death: From 5 o'clock a. m. to 8 p. m., 116; from 8 o'clock p. m. to 5 a. m., 84.

This parish has 1,206 householders and 3,362 souls; the proportion of deaths is 4 per cent. The number of emigrants in this parish was 86.

If you would know the location and other conditions of the streets in this parish, I can give to you the numbers of attacks and deaths which occurred in each street, but I have not done so because I did not suppose this useful to you. In case they should be useful, I will send them with much pleasure, as well as anything else which, through forgetfulness, I may not have mentioned in the unpremeditated manner in which my daily occupation has obliged me to make reply.

MIGUEL BAZO.

## REPLIES TO THE INTERROGATORIES CONCERNING CHOLERA PRESENTED BY THE SECRETARY OF THE MUNICIPALITY OF THE CITY OF TARIFA.

(1) *If your town has been attacked by cholera during the last epidemic, when and how was the disease introduced?*

The city of Tarifa was invaded by epidemic cholera in the month of January, 1886. The first case occurred in the Huerta del Rey (king's orchard), outside of the city, near the *paseo* of Alphonso XII, on the 11th of the month, in the person of the gardener, who concealed the premonitory diarrhœa for the space of forty hours, and asked for medical assistance only when the cramps, vomiting, algidity, cyanosis, suppression of urine, and aphonia held him at the gates of death. He succumbed on the 12th, at 10 o'clock in the morning. I believe that during the night time contraband goods from Algeciras, where cholera was prevailing, were hidden in his orchard by smugglers.

(2) *When and how did the cholera spread and become epidemic?*

On the 12th another case occurred in a woman of Trinidad street, and on the following day, the 13th, another in San Casiano street, who had worn clothing from Algeciras. From this day cases continued to be disseminated throughout the population, the reduced number of inhabitants causing close relations and easy communication.

(3) *Was the propagation of the disease rapid or gradual?*

I think it was rapid.

(4) *Was the cholera propagated from one or from several centers of infection? What was the location of these centers?*

I consider that the cholera spread throughout the town from the patient who died in San Casiano street, who occasioned the infection of his wife, and who, giving his clothing, with directions to burn them, to another woman who kept some of this clothing, the contagion being thus transported by a relative of one of the patients from the exterior ward to that of Jesús, at quite a distance. I consider that there were two centers of infection, the external ward and that of Jesús.

(5) *What measures were adopted and put into execution to prevent the introduction of the disease into the town?*

From the date of appearance of cholera in the province during the past summer a medical inspection was established, travelers from infected places were fumigated, and baggage and merchandise were disinfected. The travelers were fumigated with carbolic acid, at 5 per cent., by means of a vaporizer, in a close chamber. The baggage and effects were fumigated with fumes of hyponitric acid and of sulphur, besides being cleansed and ventilated for three days. Upon the appearance of cholera in Algeciras, and taking into consideration the constant relations between the two neighboring towns, advanced guards were posted in the highway for the purpose of requiring any traveler whatever to present himself at the bureau of sanitary inspection, where, after fumigation, he was clothed in order to enter within the town, unless he should present suspicious symptoms, in which case he was detained in the "house of health," which adjoins the bureau of sanitary inspection, as long as the state of his health inspired any suspicion; and his effects and baggage were treated in the manner already indicated. The cess-pits were disinfected with sulphate of iron, and an effort was made to place the public and private hygiene on such a footing as to leave nothing to be desired.

(6) *What measures were adopted and enforced in order to prevent the first cases from producing an epidemic? What measures were adopted and enforced after the development of the epidemic? At what date were these measures enforced?*

From the moment that the case of the gardener of the said exterior locality was recognized, by the undersigned official physician, as epidemic cholera, the authorities with a praiseworthy zeal isolated the locality and the house, destroyed by means of fire the clothing of the deceased, the bed, and all the furniture of the room which had been occupied; the place was disinfected with sulphur and hyponitric acid; the dwelling was closed, and the key kept by the mayor. The same precautions were adopted with all the cases which followed the first. The epidemic having already developed, on the 21st of January it was officially declared by



the board of health, presided over by Don Manuel Bernal, medical delegate of his excellency the governor of the province, who with zeal and intelligence organized the sanitary service for placing the town in a sanitary condition. A sanitary brigade was charged with the disinfection of the sewers and cess-pits by using a solution of sulphate of copper in the latrines of the houses where there were no cholera patients, and by using bichloride of mercury where there existed dejections of cholera patients; charged with the fumigation of the dwellings which contained a cadaver, by using chloride of lime and the fumes of hyponitric acid and sulphur; with the burning of all the clothing and bedding which the patient had used, whilst the dwelling was closed and the family lodged in another house (whenever this was possible). The public wells, which supplied the inhabitants with drinking water and which it was suspected might contain pathogenic micro-organisms, were ordered to be closed; the use of the water of the fountains or springs in the neighborhood of the town for drinking purposes was advised, for it was thought to be good. The central canal into which the sewers of the town discharge, a small brook running through the town, was cleaned out. A cholera hospital was established in the best ventilated and most isolated locality.

An economic kitchen was instituted for the supply of soup to all the sick, and of rations to the poor. The enforcement of all these measures began on the 21st of January, after holding the said meeting of the board of health presided over by the delegate.

(7) *State the character of the public supply of drinking water. By what means is this drinking water conducted into the town and distributed there? What per cent. of houses are supplied with this public drinking water? Are the upper stories supplied with this water? What other kind of drinking water is there?*

The town is supplied with potable water in the following manner: the majority of the inhabitants, from public wells and from wells which exist in the houses; this water is heavily charged with carbonate of lime; they use, besides, water from a public fountain situated in a square; the well-to-do families drink water from the springs Mojícar, Guijo, Herrumbrosa, and De Soto; the two first, at 2 kilometers, are good and contain some carbonate of lime; the two others are at 9 kilometers distance on the side of a mountain, from the bosom of which they spring, and are excellent, that of Herrumbrosa containing some oxide of iron, and that of De Soto a small quantity of arseniate of iron. The means of conduction are water carriers, who carry it from the respective places in water jars or casks. The only water brought into the town by a water conduit is that of the fountain in the Mesón Square; it is collected from various springs into reservoirs from point to point along its course, and is introduced into the town through earthen pipes. Seventy per cent. of the population use the well water and that of the Mesón Fountain, the remaining 30 per cent. using water from the springs outside of the town, and from those of the Peña Mountain.

The upper stories are not supplied with water.

(8) *If there are villages or cities situated along the course of the stream which supplies your town with drinking water—up stream from the point where that water is taken—were those villages visited by the cholera or not? In the affirmative case, at what date and to what extent? What were the names of these villages, and how far distant were they by the water course from the point where the drinking water was obtained? What was the rapidity of the current during the prevalence of the epidemic?*

There are no villages situated along the course of any stream of drinking water.

(9) *Whence does the water proceed which is used for irrigation? Does it flow by other villages before reaching yours? If so, were they invaded by cholera, and at what date and to what extent? What is the distance by the irrigation canal to said villages?*

This question is not answered, inasmuch as this district is not irrigated.

(10) *What was the character and extent of the public sewerage in your town, and what the nature of house drainage? What connection existed between them?*

Public sewers exist throughout the whole town, although they are narrow and badly constructed, often obstructed and frequently breaking in every direction, giving exit, upon the surface of the streets, to their foul contents, and permitting of filtration into the public and

private wells. All the sewers discharge into a stream, which, running from the east to the west, divides the town into two nearly equal proportions. During the seasons of rain the water in this stream rushes violently to the sea; during the summer it serves solely as a drain for the sewers of the town, and receives the contents of all the latrines, infecting the atmosphere, especially during days of calm or when the wind changes. The sewers of the Jesús ward (or district) empty directly into the sea. In the exterior (or extramural) ward (or district) there are no sewers or cess-pits, the inhabitants scattering around over the ground their dirty water and their excrement.

(11) *What relation existed in your town between the introduction and propagation of cholera and the supply of drinking water? What relation had the cholera with the public and private sewerage?*

The exterior (or extramural) ward (or district) being supplied with well water, I deem it very probable that this water may have been contaminated by filtration from the very considerable quantities of filth which existed there at the commencement of the epidemic, and that this may have been one of the causes of the propagation of the disease. Another grand focus formed in the Jesús ward, and the water of the Mesón Fountain must have had an influence in its development, for it scarcely could have escaped impregnation with impurities and micro-organisms by filtration from the sewers, which are very near the water pipes. I am of this opinion, on account of having observed that those who used the spring water of Herrumbrosa, Soto, and Mojícar, situated more or less distant from the town, have enjoyed a relative immunity.

(12) *What parts of your town suffered most from cholera? What was the condition of the inhabitants in those parts, and what the state of the sewerage in the same, as compared with other parts of the town less attacked?*

The worst-attacked parts of our town were the Jesús and exterior (or extramural) wards (or districts). The condition of the inhabitants of those wards is that of want. They have dirty, small, and badly-ventilated dwellings; they are crowded together in veritable huts, with poor and few beds, it often being necessary for two, three, or more to occupy the same bed. The courts of the houses in the extramural ward are badly paved, full of dirty waste water from the well, mingled with that which has been used for domestic purposes; the alvine evacuations are emptied into these pools, or are thrown on the ground in the vicinity of the dwellings. The courts are dirty and ill ventilated, and all the habitations are low and damp. I should not pass in silence a fact worthy of notice, that the right side of Royal street, in the extramural ward, is formed of new houses, in good hygienic condition, with proper height and ventilation, with well-paved patios (or courts); no case presented itself there. The same immunity was noted on the left side, in a few houses whose conditions were similar to those on the right. In the Jesús ward the sewerage is in the same condition as in the rest of the city, but the ward is very populous, the inhabitants living crowded together in dirty, small, and badly-ventilated rooms; the meals are prepared within the dwellings, and there are no chimneys, but there are cess-pits at the street door, frequently without covers. The food of the inhabitants of these two wards is generally bad; fish, sometimes meat or fresh pork being preferred to beef. One and all spend in alcoholic drinks the greater part of their gainings.

(13) *What were the meteorologic, hygienic, and telluric conditions in your town before, during, and after the epidemic? (This question embraces the nature of the soil and subsoil, its moisture or dryness, state of vegetation, etc.)*

The meteorological condition of the town at the commencement of the epidemic was that of rainy and cold weather, with considerable electricity, since there were sudden thermobarometric oscillations common in this region, at times, during the same day. On this account the majority of the inhabitants suffered from colds and catarrhal affections. Before the commencement of the epidemic there was very little good hygiene in this town, and it was found in very favorable condition for the development of cholera.

The telluric conditions are: a layer of considerable thickness of clay upon a calcareous stratum; the level of the ground-water is at its greatest height, because of the abundant rains



which have been experienced. Adjoining the town are lands devoted to agriculture, yielding abundant crops; there are no trees in the neighborhood except those of the public *Paseo* of Alphonso XII, for vegetation is poor on account of the strong winds which prevail in this advanced southern point of Europe; the subsoil of nearly the whole town is calcareous and contains abundance of water, which is heavily charged with carbonate of lime; a small part of the Jesús ward is located upon strata composed of sand and clay, hardened at the period of transit into rock, properly so-called (sedimentary rock).

(14) *What was the daily progress and extent of the attacks and deaths by cholera in your town?*

The following table of statistics will supply the answer to this question:

Date.	Attacks.	Recoveries.	Deaths.	Date.	Attacks.	Recoveries.	Deaths.
1886.				1886.			
Jan. 21	4	.....	.....	Feb. 6	13	6	3
22	4	.....	3	7	14	14	9
23	1	.....	.....	8	11	8	3
24	8	.....	3	9	11	3	6
25	3	.....	1	10	10	5	2
26	15	.....	5	11	18	21	1
27	13	.....	5	12	5	52	1
28	21	.....	3	13	7	21	2
29	38	8	6	14	17	9	2
30	49	8	5	15	11	17	3
31	16	21	4	16	2	9	2
Feb. 1	16	12	5	17	3	9	2
2	27	9	6	18	2	3	1
3	15	8	8	Total ..	393	276	100
4	15	17	2				
5	24	16	7				

NOTE.—These figures leave 17 attacks unaccounted for.

(15) *What appreciable influence did the preventive measures, above mentioned, have upon the course of the epidemic?*

The cleaning and careful disinfection of the most frequently attacked houses of the extra-mural ward, the closing of some of them, the thoroughness of the public cleaning, the disinfection of the latrines with bichloride of mercury and sulphate of copper; the healthy and abundant feeding of the needy classes, which was the result of the solicitude and charity of some of the praiseworthy inhabitants, of the evangelic zeal of the very excellent and illustrious bishop of the diocese, whose alms and assistance were multiplied where want, hunger, and disease made their ravages; the succor brought by his excellency the civil governor of the province, and the assistance granted by the provincial legislature and by the government at Madrid, and the donations received from Her Majesty the Queen-Regent influenced very much the decrease in the number of attacks. And it is believed that the fall of the epidemic once begun, the disappearance of the terrible visitor from the Ganges can not be far off, if we continue to practice the measures of defense which the municipality are enforcing with ardor and zeal, although at the expense of their last centime of treasure.

(16) *What are the other diseases common in your locality which so resemble cholera that at the beginning it is difficult to distinguish them?*

(Malarial) fevers, spasmodic colic, and choleriform gastro-enteritis.

(17) *What treatment has proved most efficacious in combating the cholera?*

The treatment which has seemed to me most efficient is the following:

For the premonitory diarrhoea: laudanum of Sydenham is the antidiarrhoeic superior to all others, and indisputably worthy of preference; infusion of chamomile with a few drops of *alcohol de caña* (spiritus frumenti?); rest in bed with suitable covering in order to produce diaphoresis. In the second period, when vomiting is present: mint water, ether, camphorated alcohol, some spoonfuls of sherry wine, with a few drops of elixir of paregoric, aqua albumi-

nosa, and for thirst hydrochloric acid lemonade. In the very few patients who suffered with cramps: hypodermic injections of morphia. In order to prevent the asthenic secondary fever of typhoid character, hypodermic injection of 25 centigrams of the bromo-hydrate of quinia.

(18) *If anticholeric inoculations have been practiced in your town, what were the names of the operators, the method of operating, the number inoculated, and the dates of the inoculation? Did the inoculated, as a general rule, belong to that class and to that ward which have suffered the most from the cholera? What are the facts and statistics of which you have personal knowledge respecting the harmlessness or danger and the utility or the inutility of the procedure of Ferrán?*

No anticholeric inoculations have been performed in this locality.

(19) *What number of individuals have been, according to your personal knowledge, attacked by cholera twice or three times during this same epidemic? If you have knowledge of such cases, please relate the details.*

No one has been attacked with cholera in this town for the second or third time during this present epidemic; I am able to affirm that all of those attacked have enjoyed a complete immunity against a second attack.

(20) *What have been the history and results of quarantine, sanitary cordons, and fumigations in your town during the existence of the cholera epidemic in Spain?*

We did not have either quarantine or sanitary cordons during the epidemic of cholera, only a bureau of sanitary inspection and an adjoining "house of health" at the entrance of the extramural ward. Every traveler was required to present a bill of health certifying that he had not experienced epidemic cholera in the place whence he came. He who came from a point infected with cholera was fumigated with carbolic acid of 5 per cent. vaporized by a spray apparatus, in a closed room, for ten minutes; and if he presented suspicious symptoms, he was removed to the "house of health," when he was completely isolated and subjected to observation, his baggage being fumigated with the fumes of sulphur and of hyponitric acid in a closed room, and his soiled underclothing submitted in the dry oven to a temperature of 150° C. We put these measures in force when cholera appeared in Algeciras, only 22 kilometers distant, with whose inhabitants we were maintaining frequent commercial intercourse. But in spite of multiplying our force, in order to prevent any traveler whatever from evading the sanitary inspection, I am quite convinced that the cholera was imported by smugglers (contrabandistas), who avoided the ordinary route, crossed the mountain by long, circuitous roads, came during the night to the huertas (surrounding gardens) and vineyards in the neighborhood of this town, abetted by the ignorance of these rustic retreats. Thus we explain the appearance of the first case in the Huerta del Rey (King's garden or orchard), and a second, in a laborer of a quarry near the city, who received and was clad with clothing from Algeciras and had frequent communication with individuals who bought such things, fell sick in his house in San Casiano street, and afterwards fatally infected through his bed clothing the extramural ward, as we have already pointed out in the reply to a preceding question. If the soiled and damp clothing of the above-mentioned deceased person of San Casiano street had been destroyed as a precaution, and the person charged with burning them had not retained some pieces from them for his own use, and been accompanied by a woman who assisted him in the operation, both being attacked and dying in their homes in the extramural ward, this focus might have disappeared like that in the Huerta del Rey. The widow of the resident of San Casiano street was also attacked, in consequence of her careful attention to her husband and of having repeatedly handled the soiled clothing, which continued to accumulate under the bed of the patient. The rest of the inhabitants of this house on San Casiano street did not take the cholera. This may be explained by the constant disinfection of the latrine common to all and by the isolation in their respective apartments in which they were kept; thus it is that the house which infected the whole town has nevertheless not been a focus of contagion for its own inhabitants. By these facts it is shown how difficult it is, even when taking the most scrupulous care, to subject travelers to a sanitary inspection. The majority seek to evade it, and there are always those who are disposed to conceal the infraction, refusing to make known



how and when the evasion was accomplished. So certain is this to happen that the undersigned (chief of the health office during the above-mentioned epidemic) had suspected, and so expressed himself, that we were exposed to the contagion through what might occur in the huertas, vineyards, and quarries near the town.

(21) *What measures have been adopted for preventing the re-appearance of the cholera during the next summer? And what improvements have been effected with respect to public hygiene, water supply, and sewerage?*

As the epidemic has not yet terminated, the local board of health have not discussed the measures which should be instituted for the re-appearance of cholera during the next summer. They have not yet effected improvements in public hygiene, but they contemplate diverting the stream which traverses the town, by giving it a new course which will take it out into the sea before it reaches the walls. This project already determined upon by us is now in the hands of Her Majesty, with the request for her immediate approbation before commencing the work of making the necessary modifications in the system of public sewerage, by covering the present course of the stream and causing the disappearance from sight of this great central sewer which now carries, in the light of day, the products of all the latrines of the city and constantly infects the atmosphere with its emanations. It is also intended, and it is an urgent necessity, to bring the potable water from various springs on the Peña Mountain—excellent water, as already remarked, some containing oxide of iron, others a small quantity of arseniate of iron.

(22) *Have any vestiges of cholera remained to your population during this or the previous winter, either as isolated cases which have appeared from time to time, or in the form of a localized epidemic?*

From the year 1855 this town has had no cholera epidemic until the present one which we are now suffering.

(23) *What has been the number of deaths in your town for the last five years?*

The following table will give the answer to this question:

*Number of deaths during the last five years.*

Years.	Deaths.
1881 .....	348
1882 .....	400
1883 .....	374
1884 .....	396
1885 .....	305
General total .....	1,788

(24) *If your town has not been invaded by cholera, or, on the contrary, if it has been so one year and not another, to what was the immunity attributed?*

The reason that this town has not experienced an invasion of cholera since 1855, although it has been in the Peninsula several times, is found, as I believe, in the scant communications with other towns, because of the small commerce which we maintain—our mercantile transactions being reduced to the exportation of our cereals and cattle to the neighboring markets of Cadiz, Gibraltar, or Malaga, and to the importation of all kinds of textures also from the same points.

(25) *What was approximately the number of persons who abandoned your town during the epidemic?*

The population of Tarifa, including the rural, is 11,962 inhabitants. Of this about 5,000 live constantly in the fields; the rest dwell within the town. Of the latter, assuredly more than 2,000 migrated at the commencement of the epidemic. There remained, therefore, in the city, according to the data from the secretary of the municipality, some 4,000 souls.

There remains now to be mentioned the notable fact which has been always observed when we have been visited by cholera. In 1834, 1854, 1855, and at present 1886, there has not been

a single person attacked within the fort of the island of Las Palomas, half a kilometer distant from the town. The garrison there located, the families of the officers, the employés of the light-house (which is situated on this island), form together a contingent of 150 persons, without interruption of communication with the town. Nevertheless, all have remained in perfect health. It is believed that the chief reason of this is to be found in the pure water of a cistern, cut out of the rock and perfectly closed with flag-stones, absolutely prevented from receiving organic vegetation or animal detritus, for the whole island consists of a stratum of rock of marine formation, very rich in fossils, which is several meters thick, above a subsoil of sedimentary rock.

The reply to the interrogatories being ended, the subscriber only desires that the observations and data which he has offered may entirely meet the object which his distinguished confrère has had in view, and he considers himself very much honored in aiding him in the arduous task with which the Government of the United States of America have charged him for the good of humanity and of science.

FERNANDO LLANOS.

TARIFA, *February* 19, 1886.

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REPLY TO THE INTERROGATORIES RELATIVE TO CHOLERA IN THE CITY OF TERUEL, PROVINCE OF THE SAME.

(1) Yes. The first suspected case occurred on the 27th of June in a wagoner coming from Valencia, but the epidemic may be said to have begun on the 5th of July and ended on the 3d of September of 1885. It is believed to have been introduced by the above-mentioned wagoner.

(2) On the 5th of July it became epidemic, and it appeared to spread by contagion.

(3) It was gradual.

(4) From several; in the most populous and least hygienic wards.

(5) Lazarettos at convenient locations, and cordons.

(6) The most complete isolation possible; disinfection of the sewers with chloride of lime; the distribution of quicklime among the dwellings, intended for use in the courts and latrines; the publication of directions concerning the cleaning of houses, and the appointment of local commissioners charged with seeing these directions fulfilled. These measures were enforced even before the commencement of the epidemic with the object of preventing it.

(7) At 4 kilometers from the capital and to the northeast the water is obtained from the Fondo del Cuba, in a gully, and is conducted to the town through terra-cotta pipes, except a short distance through iron pipes; the quantity is small, but the quality is very good at the point where it is obtained. The gypsum soil through which the earthen pipes run and the bad condition of the latter, however, cause the water, by the time of its arrival in the town, to be considerably charged with gypsum. The immense majority of the inhabitants use the water of the river Guadalaviar (Turia) on account of its good potable qualities.

(8) There is the village of Gea which was attacked, I do not know at what date. It is 4 leagues distant from this, and the fall of the river is 1 per cent.

(9) From the river Turia, and the water passes by the village of Gea before reaching this town. But Gea was attacked subsequent to the invasion of this capital.

(10) The sewerage is of small extent, and the inhabitants throw their filth into the courts.

(11) The spread of the cholera was most observed among inhabitants who used water unfit to drink, and the greatest number of attacks occurred where there were no public sewers.

(12) Already stated; the majority of the inhabitants are laborers; no sewers.

(13) During the existence of the cholera epidemic the weather was very dry and extremely hot, with strong, hot southerly winds. The land is alluvial; the soil of the city is clay. The real city is situated on a plateau upon a hill, completely isolated, the subsoil of which consists of a stratum of very hard conglomerate, almost rock; on account of the impermeability of the latter and the absence of a good net-work of sewers, the lower stories of all the houses are damp.



(14) Gradual, and during the middle period the number of deaths fluctuated between sixteen and twenty-four.

(15) It could not be appreciated.

(16) There is no common disease which could be confounded with cholera, for intermittents are scarcely ever experienced, and much less those called pernicious.

(17) Every mode of treatment was tried, and I could not form an opinion; all that I can say is that some cholera patients in the stage of asphyxia were saved by hypodermic injections of carbonate of quinia, of sulphuric ether, and of strychnine.

(18) No anticholeric inoculations were performed.

(19) I know of none.

(20) Negative, as respects quarantine and sanitary cordons; as respects fumigations, I think that they probably contributed towards checking the propagation of the disease.

(21) I know of none, and of no improvement in hygiene.

(22) None.

(23) About three hundred per annum.

(24) This town was not invaded in 1884, doubtless on account of the slight increment of the epidemic in Spain; it was attacked in 1885, according to my opinion, by reason of the great spread of the disease in the province of Valencia, with which we were in very frequent communication through our commercial relations.

(25) There was scarcely an inhabitant who fled during the epidemic.

MANUEL LEGA,

*The Subdelegate.*

TERUEL, *February 11, 1886.*

REPLY TO INTERROGATORIES CONCERNING CHOLERA IN THE VILLAGE OF MORA, PROVINCE OF TOLEDO, 1885.

(1) This village was invaded by cholera on the 24th of July. It was believed to have been imported by persons who were in communication with effects or persons of the neighboring village of Mascaragua (some 4 kilometers distant), infected at that time.

(2) The disease was propagated and became epidemic from the first cases.

(3) Its spread was gradual, and from person to person.

(4) There is no information of more than two centers; one of the individuals coming from Mascaragua and the other having an origin unknown.

(5) The measures adopted consisted in cordons formed by the inhabitants, spraying of carbolic acid, fumigations of sulphur, and the observation of persons coming from infected points, the execution of the above mentioned measures being very defective.

(6) Isolation, disinfection, and the burning of contaminated objects in the houses first infected. Afterwards the said measures were continued, except that boiling of everything which was capable of being subjected to this operation was substituted for burning, up to the end of the epidemic; but there being no special persons assigned to perform these operations, there was much left to be desired in the efficiency with which these measures were enforced.

(7) The supply of drinking water for the town is furnished usually by wells, and the distribution by means of water carriers.

(9) The water for irrigation also proceeds from wells, water-wheels being used for the purpose of drawing the water.

(10) There is no system of sewerage. The drainage of dirty water is into the sinks which exist in every house as also into the public streets.

(12) The streets in which the epidemic was worst were those to the north, low and wet, those attacked being laborers and of the poorer classes.

(13) Oppressive heat accompanied by great moisture and an electrical condition of the atmosphere, with some storms. There was but little vegetation, a condition which is always

customary at that time of the year by reason of the scarcity of water and the poor nature of the soil, which latter is composed in general of sand and slate.

(14) The progress and extent were slow and the daily mortality did not exceed an average of four.

(15) No influence of any kind during the course of the epidemic could be visibly attributed to the preventive measures adopted.

(16) Cholera nostras and sporadic cholera.

(17) In the midst of the disorder and sanitary confusion which prevailed during the epidemic it was not possible to appreciate the effects or to put in practice many of the various methods of treatment which are advised; but it was noticed that laudanum of Sydenham always produced a very good effect when it was opportunely employed, as well as the sudorifics and quinia.

(18) The inoculations of Ferrán were not employed.

(19) I do not know of any except some in the anterior epidemics.

(20) Quarantines, cordons, and fumigations were imperfectly practiced, exaggerated at times, very defective at others, and subject to the caprice of the authorities.

(21) No sanitary measures have been adopted up to the present date.

(22) No vestige of the epidemic has remained since the 8th of September, when it ceased.

(23) The deaths in this town during the last five years are upwards of 1,238.

(25) A third of the population deserted their houses in the first fifteen days after the declaration of the epidemic.

Dr. LORENZO SEBASTIAN.

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REPLIES TO INTERROGATORIES CONCERNING CHOLERA IN THE CITY OF ORGAZ (CAPITAL OF THE JUDICIAL DISTRICT), PROVINCE OF TOLEDO.

(1) Four persons were severely attacked on the 20th of last August, 1885, in consequence of being in communication with the villages of Mora and Mascaragua (distant 8 kilometers), which were attacked with cholera.

(2) The 23d of the same month three other grave cases occurred, attributed to a new importation of the germs of cholera, and from this date the propagation of the disease began, although with a markedly benign character.

(3) It was gradual.

(4) Seven poor families at different times and in different localities of the town were severely attacked.

(5) Public and private hygiene and isolation as far as it could be maintained.

(6) Perseverance in hygienic measures (fumigations, drainage of ponds of water, cleaning of houses, streets, and public thoroughfares, disinfection of latrines, prohibition of bad food, the removal of herds of hogs, separation of the sick and convalescent, proscription of the use of the water of ponds and of suspected water, etc.) was continued in the dwellings of the sick, the most scrupulous cleanliness being required. The houses of the sick were washed with chlorine water, sulphur was burned, the clothing and contaminated effects were totally destroyed by fire when the patient died or was cured. These measures were adopted anterior to and at the time of the invasion and were enforced during the whole course of the epidemic.

(7) The use of water, evidently pure, proceeding from a spring and closed aqueducts, was alone permitted, and an effort was made to see that the inhabitants daily cleaned the water-casks.

(8) No.

(9) All the drinking water, as well as that for irrigation, originated within the town.

(10) There is no general system of sewerage. The people of the town being addicted to agriculture, the offal and household drainage, serving as manure for the ground, are transported to the fields at the proper season.



(13) The atmosphere was warm and moist. The soil was dry and the subsoil slightly damp, by reason of its constitution, for it consisted of alternate layers of clay and gypsum with lime or granite. As to the state of vegetation, it only deserves to be mentioned that the vines for years have suffered from oidium, and the disease was much aggravated during the past year, as it assumed the character of the mildew.

(14) Only data concerning the grave cases were preserved.

Date.	Cases.	Date.	Cases.
Aug. 20 .....	4	Sept. 8 .....	1
23 .....	3	13 .....	1
24 .....	1	19 .....	1
28 .....	1	Total .....	16
Sept. 1 .....	1	Cured .....	10
3 .....	1	Died .....	6
5 .....	2		

(16) Different forms of malaria; but whilst pernicious diarrhœic intermittent fever may sometimes be confounded with the algaid period of cholera, the similarity is illusory, for neither the *ensemble* of symptoms, nor the results, nor the observance of recurrences is the same, the latter being an especial character of malaria, whilst it is only exceptionally observed in cholera.

(17) There being no specific, I have given preference to the expectant treatment to the end of favoring elimination of the choleraic agent, preferably by means of diaphoresis, and in consequence have used opiates (opium in extract, Dovers powder, laudanum, morphia), alone or in conjunction with sulphuric or hydrochloric lemonades, teas, hot, warm, cold, or iced, according to the phases or the nature of the attack. With these measures and others less important I have been able to reduce the total mortality to six persons.

(18) Preventive inoculations were not performed in this town, notwithstanding my desire, for I am decidedly in favor of them. If the Spanish Government had not placed difficulties in the way of the system of Ferrán it would probably have been tried in this town, and the greater portion or the entire number of the inhabitants, if possible, would have been inoculated.

(20) The efficacy of the isolation of individuals was demonstrated, but the value of isolation of collections of people has not been so certainly established, because of the common failure to rigidly enforce it. I consider fumigations advisable for the sterilization of the air and for the disinfection of soiled clothing and other effects, and would employ, besides, the ventilation of apartments for some days. Fumigations were practiced very extensively in this village, but I consider them useless, antiquated, troublesome, ridiculous, and even prejudicial when they are applied even for a short time to persons.

(23) It reached the number of 385 deaths, the greatest mortality corresponding to the two years from 1881 to 1882, and from the latter to 1883, an epidemic of diphtheria having existed at that time. The total census of this town was 2,774 inhabitants.

ANDREAS SALGEDO,  
*The Official Physician.*

ORGAZ, February 7, 1886.

#### REPLIES TO INTERROGATORIES CONCERNING CHOLERA IN THE VILLAGE OF QUERO, PROVINCE OF TOLEDO, 1885.

The actual although not official census is 1,900 souls.

(1) On the night of the 1st of July last the first case of cholera appeared, and on the 29th of August occurred the last attack. It is unknown exactly how the disease was introduced.

(2) In eight days after the first case the disease assumed an epidemic character.

(3) Gradual; for the epidemic was slow in reaching the period of its height—twenty days.

(4) The formation of foci or centers of infection could not be traced to their origin, for during the first week the cases occurred in different points of the town and among persons who had no relation with each other, and moreover we isolated the sick and their families. The two large foci in the town were in two opposite quarters and under different hygienic conditions, for while the one was towards the northern portion the other was located in the southern part, the former dry and the latter damp, there being in both many individuals living under miserable social and hygienic conditions. It was these who formed the real foci, being ready to propagate contagions of all kinds.

(5) Cordons and lazarettos according to recent ideas, more by an excess of fear than supported by scientific reasoning, are demanded. (As if a few watchmen were able to impede the course of surface and subterranean waters, the direction of the winds, the migration of animals, and the thousand and one other things which may transport the contagion !)

(6) Absolute isolation of the patients and their attendants, the closing of the house after fumigation subsequent to the death of the patient, and finally the isolation of the attendants, either in the fields or in another purified house. After the spreading of the epidemic similar measures were continued; although it was not possible to guard all the houses under authority, fear guarded them in a more efficacious manner. I ought to mention that isolation causes more evils than benefits, because it increases the terror and serves to excuse the cowardice which allows patients to die without it being known that they were sick, and as this augments the mortality, as a natural and logical consequence in its turn it increases the fear which predisposes to an attack of the prevalent disease, and consequently to the spread of the epidemic. The isolation should not, therefore, be enforced, because it occasions terror. It interferes constantly with hygiene and the measures necessary to combat the epidemic in its origin.

(7, 8, and 9) This town is supplied with water from wells within its limits. Irrigation water is absolutely interdicted for domestic purposes.

(10, 11, and 12) In these small villages there exists no sewerage, and all the filth and excrementitious matters are deposited in sinks, of 2 to 3 meters depth, which exist in all the houses, open to the air, whence the contents are removed according to the requirements of agriculture.

(13) This village is situated in the broad plain of La Mancha. Its climate is varied, and the changes are sudden and frequent. The variations of temperature are extreme and the rains abundant. During the epidemic, and coinciding with its height, were heavy and frequent rains, and during the same night the mortality reached its highest figure. The fall of the epidemic coincided with the return of customary weather and the dryness appropriate to the season. The hygienic conditions of the people were good in so far as they depended upon the nature of the locality, and miserable in so far as they depended upon the actions of men, for the regulations could not be more rudimentary. The soil is clay and there is a predominance of lime.

(14) We have already said that the period of increase lasted twenty days followed by eighteen days of the stationary period and twelve of the descent—the total number of attacks being two hundred and twenty, the corresponding deaths being sixty-five.

(15) The sole measure in which there was any evident efficiency has been the closing of the house where a death occurred and removal of the survivors to another clean house or to the field. In none of the cases in which this was done did the disease recur in a family, and in those families which by reason of special circumstances it was not done there were various attacks and not a few deaths.

(16) The sole disease that is somewhat similar is catarrhal diarrhoea, but ordinarily, in my opinion, this can not be mistaken for cholera.

(17) Repecting the popular repugnance to the employment of laudanum and all kinds of drinks, I employed subnitrate of bismuth and opium, in the proportion of 2 grams of the first to 3 centigrams of the second, repeated according to the requirements of the diarrhoea, and I found its employment very useful in the first period, which is that in which medication is most effective. Ice is the agent which in my hands has best arrested vomiting. I have not



met with any drug which has proved efficacious in the third period, being inclined to attribute the cures in this stage more to the effect of spontaneous and natural reaction than to medicine which is not absorbed. Hypodermic injections of ether have been followed with negative results.

It should be noted that in spite of having made use of opium considerably, I have not noticed any indication of narcotism or any other of its toxic effects, so much is the power of absorption diminished in this disease.

(18) No.

(19) None. Some believing themselves cured, but the diarrhea not having completely disappeared, have practiced abuses in diet and exercise and have suffered a return or, to speak more exactly, an exacerbation of the disease, and died in a few hours.

(20) This has already been answered.

(21) None. In this country we live from hand to mouth, and do not at all remember past fears or take account of the future.

(22) No. At least up to this date there has been no indication of its existence.

(23) The total number of deaths in the last five years is two hundred and forty.

Cholera would be the least fatal of epidemics if the money spent in cordons, lazarettos, and fumigations were employed in improving the food and mode of life of the inhabitants; in supplying medicine gratis to all the sick (here this has been done because we have no drug-store); and increasing at the beginning the number of physicians, not only for the purpose of visiting the sick, but the healthy also, in order to instruct them constantly concerning the rules of hygiene and the best mode of life which should be observed to preserve health and remove that terror which increases and aggravates the danger of the disease. In fact cholera is combated with money and with good moral and social conditions.

LDO. MANUEL PONES AGUADO.

QUERO, *February 6, 1886.*

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REPLIES TO INTERROGATORIES CONCERNING CHOLERA IN THE TOWN OF TEMBLEQUE, JUDICIAL DISTRICT OF LILLO, PROVINCE OF TOLEDO.

(1) This town was invaded by cholera. On the 29th of June the disease presented itself in a woman of this place who came from Aranjuez (greatly afflicted by the epidemic). In order to avoid panic and fear, and on account of other public reasons, such as preventing the exodus of the agricultural harvesters, the disease was called acute enterocolitis. Among the agricultural laborers were some proceeding from Villacañas, a point suffering severely from the epidemic, and some of them began to suffer from diarrhoea and vomiting by the middle of July; they were brought from the fields into the town in a pretty bad condition, some of them dying.

(2) From this date (middle of July) cases occurred so frequently that it was determined to officially declare the epidemic. From the first woman proceeding from Aranjuez the disease passed to her husband with an interval of five days, and from these to other inhabitants of the same ward. With respect to the harvesters, the disease was carried from one to another. At the end of July the epidemic was already so intense that the civil authorities (who are in Spain the sanitary authorities) were obliged to officially declare the town infected with the epidemic. The propagation of the disease increased gradually, although in an irregular manner. This propagation was from two centers of infection as above indicated, the one located in Aranjuez, the other in Villacañas. The measures which were adopted and put in execution to prevent the introduction of the disease in this town were: First, obliging travelers to pursue their journey without stopping, only allowing them to obtain the necessities for their sustenance; second, in prohibiting the entrance of those coming from points infected unless they belonged to this locality; third, the isolation for the space of twenty-four or forty-eight hours of those inhabitants of the town who might come from an infected or suspected point. But these measures were not enforced with rigor; the fumigations were imperfect, since they consisted in

the dissemination of chlorine in the neighborhood of the persons, and in spraying them with carbolized water of the strength of 1 per cent. The isolation was very incomplete, and at all times the travelers communicated with the guards who watched them, receiving objects, money, wine vessels, handkerchiefs, etc.

The entrance of merchandise from infected points was also prohibited, as also the use of unripe fruits and unhealthy food; but the imperfect inspection was frequently ridiculous, and during the epidemic, on account of the evasions of the people who furnished food, the latter was no better than ordinary. There existed here no medical inspection such as is required in well-governed countries.

(6) In order to prevent the first cases from producing an epidemic, the sick and their dwellings were isolated; but this isolation could not be enforced in a perfect manner because the people thought this measure an unnecessary interference with their liberty.

The epidemic once developed, the greatest cleanliness as to the supply of drinking water (from wells) was endeavored to be secured by placing guards to watch over its service; the removal and the interment of corpses was provided for; instructions were given for the washing of the clothing of the sick, the principle being the boiling of the clothing or submitting it to a temperature superior to 100° C. before being washed; the dwellings were disinfected with nitrous acid, produced by pouring nitric acid upon a piece of copper; the earth was drenched with chlorine water (solution of hypochlorite of lime) and with a solution of carbolic acid, of 4 per cent.

The board of health was divided into sections, in order to supervise the enforcement of these measures; a hospital for cholera cases was established for the harvesters and for strangers; perfect cleanliness of the dwellings was ordered, and visits were made for the purpose of enforcing these orders; finally, the municipality furnished disinfectants, medicine, and food to the necessitous.

The date at which these measures were adopted, as far as isolation of the sick is concerned, as also the disinfection of dwellings and fumigation of the clothing, was at the appearance of the first case at the end of June; all the other measures were put in practice from the 31st of July.

(7) The supply of drinking water for this town is derived from wells whose depth is from 3 to 5 meters. The introduction and the distribution of the water is accomplished by means of casks carried by carts or by horses, and it is served to all the houses, for there is no other potable water or other means of serving it, nor is there any other water supply. In the town there exists a multitude of wells containing gypsum and bitter water; of the potable water there are only four or five wells.

(8) There existing no running water in this locality other than that proceeding from the rains, it is not necessary to occupy myself in answering this question, nor the following, No. 9.

(10) In this town there is no system of sewerage of any kind; the rain water is led off by open canals to the plain, where it forms ponds periodically; the dirty water from the houses is emptied into the court-yards, and some of it, especially that from the washing of clothes, is emptied into the street.

(11) The introduction of cholera into this town could have no relation with the supply of water, unless there existed subterranean currents of unknown origin; the rest of the question does not apply to this locality.

(12) The whole population has been affected by the cholera, but of the two points in which it has been worst, the one is elevated and airy and the other is low and but little ventilated; in both, the conditions of the inhabitants are similar.

(13) The meteorological, hygienic, and teluric conditions before, during, and after the epidemic were very regular, except as respects the existence of a pond which was formed by the spring rains about 500 meters distant from the town in a northwesterly direction, and had a diameter of some 150 meters and a depth of 65 to 70 100ths of a centimeter. This pond formed during the time of the collection of fruit which could not be removed; it was in a rotten condition and totally destroyed.



The temperature is always varied in this locality, vacillating in winter between zero and 8° C., and in summer between 25° and 38° C. The mean atmospheric pressure is that comprised between 0.760 and 0.766. The sky is usually clear to such an extent that there scarcely pass three consecutive days without the sun appearing in all its brilliance. The rains are scarce and the air is generally dry. The prevalent winds are west and north. The town is situated at a height of 635 meters above the level of the sea, in a plain of an irregular form approximately circular and surrounded at a distance of 5 or 6 kilometers on every side by limits whose elevation varies between 25 and 70 meters above the level of the town. In this plain many ponds are formed as above mentioned; the ground is level, clayey, and saline to such an extent that even within the town there is a factory for the manufacture of nitrate of potassa (at present, however, this is not active). In the lower stories, but little inhabited, efflorescences of this salt cover the walls. The subsoil is silicious clay, and is found at a depth of about 1 meter. Water is found usually at a depth of about 3 meters. Vegetation is scarce; there are no trees except those which are cultivated, and they grow slowly and live with difficulty, rapidly age, and soon die. The formation of ponds occasions malaria, most frequently in the form of intermittent fevers.

The sudden changes of temperature determine pharyngeal and laryngeal catarrhs and pulmonary affections. Insufficiency of food, united with the action of substances contained in the water, occasion scrofula, herpes, and divers forms of skin disease. Heterotrophic lesions and epitheliomas also are frequent; carcinomas and other growths, consisting of abnormal proliferation of the cellular elements, are observed.

The presence in the court-yards of manure and dirty water gives origin to diseases of a typhoid character, which, without being frequent, are yet constantly met with.

In fine, we have a clinical picture of disease, very varied, which causes one to understand that the local hygienic conditions leave much to be desired. These conditions, customary in this locality, prevailed before, during, and after the epidemic.

The sanitary service is so badly organized that instruments for observation in this town are wanting, as they are also in the vast majority of the towns of Spain.

(14) The daily progress of the epidemic of cholera in this town did not follow any constant course; but it went on increasing with alternations up to the 19th of August, from which date it decreased, also with alternations, up to the 6th of September, when no new case occurred.

On the 11th a new case again presented itself, followed by various others on subsequent days up to the 17th; on the 21st the epidemic revived again with considerable activity, sixteen new cases occurring, and increased up to the 25th, from which date it decreased again until its final disappearance on the 1st of October. (The author here introduces detailed tables of attacks and deaths with corresponding dates, which I omit.)

(15) The influence which can be attributed to the preventive measures during the course of the disease may be expressed in the following terms, according to my observations:

In general, the isolation of the sick with their attendants limited the progress of the disease, if an extreme cleanliness in their persons and in their habitations was maintained. The want of assistance to the sick favored the propagation of the epidemic.

The washing of the clothing of the sick increased the propagation of the disease much more than contact of healthy persons with the sick. When the clothing was submitted to a temperature superior to 100° C. for the space of an hour, by boiling it in water before washing, the disease did not spread.

The cholera hospital, where the attention to the sick by the nurses was more imperfect and the cleanliness less scrupulous, constituted a genuine focus, for the destruction of which vigorous fumigations with nitrous acid and washing with carbolic water were necessary.

A scrupulous personal hygiene, if it did not prevent cholera, at least made it more difficult for one to acquire the disease.

(16) In this locality there was no difficulty in diagnosing cholera; but the diseases here with which it might be confounded are diarrhœa of dentition in children and colics occasioned by excesses in eating.

(17) The most efficient treatment of cholera in this locality has been: Requiring the patients to keep the bed; producing perspiration by warm infusions with a teaspoonful of alcohol added; frictions and application of warmth to the body; in addition to this, when necessary, hypodermic injections of pilocarpine of 1 per cent., introduced by means of a syringe of Pravaz, which contains sufficient for one or two injections; clysters containing laudanum of Sydenham in the dose of 8 to 20 drops and in a quantity not to exceed 2 grams daily.

I combated vomiting with ice or iced lemonade; this has been very efficacious when given in abundance, as well for vomiting as for thirst. The antiemetic mixture of Riverio alone or mixed with laudanum is also useful, as are cataplasms upon the pit of the stomach of warm flaxseed to which laudanum has been added.

If the clysters with laudanum of Sydenham were not sufficient to suppress the diarrhœa, I employed with usefulness hypodermic injections of the chloride of morphia.

I subjected the patients to absolute fasting at the commencement and until the suppression of vomiting and diarrhœa, prescribing for them rice at first, afterwards a small portion of pigeon, and finally soup with pigeon. I tried without result the salts of quinia in conjunction with carbolic acid according to the formula of Dr. Mæstre, and as a substitute for this solution the bromide of quinia of 10 per cent. Neither have I been able to demonstrate the efficiency of injections of chloral or of astringents, and in view of this, and of the experience of other physicians, I soon ceased these attempts.

Neither did I deem it advisable to try other measures, since, as above stated, the treatment used had given me so favorable results. I should remark that excessive quantities of laudanum are extremely prejudicial and small doses inefficacious.

(18) In this town anticholeraic inoculations were not performed, and I am sorry that I have not been able to contribute to the progressive impulse which the distinguished Dr. Ferrán has given to science.

(19) Among my patients there have been attacked for the second time during the recent epidemic—

*First.* A child of Juan José Carincero, of this place, who was attacked on the 4th of August and was visited on the 5th. A son of very poor parents, he lay upon a miserable bed with scanty covering. On entering the dwelling I found him already in the asphyxic period, with the lividity and loss of consciousness common, with very frequent vomiting and diarrhœa, the dejections augmenting the moisture of the habitation, which is never found clean.

*Prescription:* Warm infusions of the leaves of the bisa (an oriental plant) with a few drops of alcohol; warmth to the feet and to the surface of the body; emollient injections with laudanum every half hour until the diarrhœa ceased; small pieces of ice constantly in the mouth and iced lemonade.

On the same day the vomiting was arrested and the diarrhœa was also much diminished.

On the 6th the same treatment was continued except the ice.

On the 7th the diarrhœa had disappeared, the general body heat had increased, and consciousness returned.

On the 8th the patient was thirsty and demanded iced lemonade, which was given to him; he drank with much avidity; I prescribed a small ration of pigeon twice a day and two portions of pigeon soup.

9th. The food was increased by one ration.

10th. The patient got up from the bed very weak. His food was increased and he was allowed to take it five times a day.

11th. I discharged him.

On the 18th of the same month I was called again to see the same child, whom I found with the same symptoms as in the anterior attack, and placed him under the same treatment, but he died the following day.

*Second.* Polonia Lopez, a native of this town, 25 years of age, married, was attacked with diarrhœa and vomiting on the 13th of August; besides experienced aching of the bones, pain in the stomach and fever. She was eight months pregnant.



Prescription: Infusion of the flowers and leaves of the *bisa* with a spoonful of alcohol in each draught. Enemata of emollients with eight drops of laudanum of Sydenham; diet of rice.

14th. The vomiting and diarrhœa had ceased; the tea infusions and clysters of laudanum were suspended; diet of soup and pigeon.

15th. Excellent condition. Cured.

Fourth of September I was called to the same patient and at the first visit they told me that since the former attack neither the general malaise nor the pains in the stomach had entirely disappeared; that on the night of the 2d there had been much diarrhœa, and besides some labor pains; at 1 o'clock on the morning of the 3d a child was born; on the 3d she had during the whole of the day abnormal pains, but without diarrhœa.

4th. The day upon which I was called I found her with a diarrhœa, non-choleraic, and with a flow of the lochia.

Prescription: Draughts of an infusion of the leaves of the *bisa* alternating with rice, and ordered a reduction of food to half a ration.

5th. Diarrhœa continued, as also the flow of the lochia; vomiting occurred; applied the child to the breast; it was attacked with vomiting and died in six hours with all the symptoms of the asphyxic stage; the choleraic symptoms of the patient gradually lessened.

Prescription: Infusion of the leaves of the *bisa*, heat to the body, clysters of laudanum, and absolute fast.

6th. Same symptoms continued; the thirst and vomiting decreased.

Prescription: Barley water as desired, small pieces of ice continually for the mitigation of thirst and the vomiting; clysters of warm water with almonds and beaten white of egg with eight drops of laudanum.

7th. Some diarrhœa; the same treatment, to which was added the anti-emetic mixture of Riverio.

8th. Vomiting has disappeared, diarrhœa ceased.

Prescription: The anti-emetic mixture was suspended, as also the ice, of which she had consumed 16 pounds in forty-eight hours; the clysters of laudanum were also suspended, and in their place was substituted an emollient enema of F. E.

9th. Continued with the enemas, etc.

10th. Four or five diarrhœic bilious passages, not choleraic; much debilitated.

Prescription: Continued that of the previous day and added weak pigeon broth.

11th. Two or three bilious passages and great debility; the lochia continued to flow.

Prescription: Food was increased—solid food—pigeon, mutton in small quantities and frequently.

12th. Two bilious passages; the lochia continued and an inflammation of the right parotid gland appears, an affection for which she has a tendency (the child seems scrofulous).

Prescription: To the other treatment, friction with belladonna ointment in the region of the parotid gland is added, and a large poultice of flaxseed flour is applied over the same region.

13th. Could not masticate the mutton; broth in which chicken, ham, and mutton were boiled frequently given.

14th. The same condition, in which she continued up to the 23d, when the parotid tumor was opened; from the opening flowed a large quantity of laudable pus.

24th. She could already eat solid food. Pus continued flowing from the tumor. She continued in this condition up to the 22d of October, when the wound and the tumor healed.

From that date her health improved.

*Third.* Asuncion Oiliveros, a native of this town, twenty-four years of age, married and two months pregnant; good constitution and habitual good health.

On the 12th of August Francisco, the husband of Asuncion, called upon me and requested my assistance for his little son, who, according to him, was expiring. Immediately, as I entered his house, I saw Asuncion reclining upon a broad bench and clothed, but with a

countenance characteristic of cholera; I was not detained long by the child, whom I found indisposed, but in no danger of death, and I went out to see Asuncion. In answer to my interrogatories she informed me that she had suffered for two days with diarrhœa. I caused her to immediately go to bed. Ordered infusions of the leaves of the bisa with alcohol and an enema with six drops of laudanum and gave her a hypodermic injection of pilocarpine.

At the second visit on the same day I found her much improved, the pilocarpine having had a brilliant effect; the diarrhœa had disappeared.

13th. In the morning I found the husband in the same bed and suffering with diarrhœa and vomiting. I ordered that another bed be immediately prepared in order that the two patients might be separated, which was done.

Whilst the bed was being prepared I noticed that the cholera which Francisco was experiencing was most intense, and in order to gain time I gave him a hypodermic injection of chloride of morphia and another of the carbolate of quinia. Ordered also warmth to the body, injection of ice and cold barley water.

At the second visit on this day I found Asuncion up and dressed and Francisco so bad that I ordered him to prepare for death. The patient died that same afternoon, which was that of the third day.

Neither Asuncion nor the child experienced any new symptoms.

The 29th of the month of August I was called to see the same Asuncion, whom I found for the second time attacked with cholera.

She had on the previous day experienced a marked chill and afterwards vomiting, diarrhœa, and giddiness in the head to such a degree that she fell upon the floor and had abdominal pains besides.

Prescription: Ordered her to bed and warmth to the surface of the body; infusion of the leaves of the bisa, laudanum enematas.

30th. All the symptoms remitted.

Prescription: The enemata were suspended; ordered rice food.

31st. The disease had disappeared.

Besides these three cases I am assured that there were two or three other cases of recurrence of cholera in this locality.

It should be remarked that the child of case No. 1 was surrounded by very bad hygienic conditions; that the patient of the second case besides being pregnant was not free from abdominal pains during the period between the attacks, and finally that the third case upon the death of her husband was taken to the house where a few days before her brother-in-law had died. This house was very badly ventilated. According to my opinion it should not be lost sight of that almost the whole of this population was appreciably influenced by the malignant action of the cholerigenous agent; and it is questionable or, to speak more exactly, doubtful if these three cases which I have just related were really a recurrence of cholera or, on the contrary, solely exacerbations or relapses after remissions of the disease.

(20) The history and results of quarantines, sanitary cordons, and fumigations has already been given in this communication in answer to question sixth, but I would add that the three above-mentioned measures have been practiced in this town, although in a very imperfect manner, and the results were not satisfactory.

Quarantines of twenty-four hours were imposed upon those inhabitants of the town who came from infected points and of fifteen days upon strangers proceeding from infected points. This measure protected us from a genuine invasion by the inhabitants of Aranjuez who thought of coming here. Some eight or ten individuals passed this quarantine in an excellent building, at a convenient distance from the town.

With respect to the cordon, this measure was infracted alternately by the strangers and by the inhabitants of this neighborhood, but it freed us from the presence of poor travelers who might certainly have propagated the disease.

Concerning the fumigations and manner in which they were performed we have already spoken. I would add only that the effect in this locality has been beneficial and the procedure



has not resulted in inconvenience. Upon some persons in particular we used thymol for fumigating the clothing and the result appears to have been good.

(21) In this locality no measures against preventing the return of the cholera next spring have been adopted, in spite of my advice and exhortations. Neither has there been any improvement made in public hygiene, notwithstanding my recommendations in this direction.

(22) In this town no vestiges of cholera, either as isolated cases or in the form of a localized epidemic, during this winter nor the last, have been observed.

(23) The death statistics of this place during the last five years are as follows:

Years.	Deaths.
1881.....	111
1882.....	133
1883.....	94
1884.....	88
1885.....	261

(24) Our population has not enjoyed an immunity against cholera since 1825. The approximate number of persons who fled the town during the epidemic was some sixty or seventy.

BURGUNDOFERRO GARCIA ORTEZ.

TEMBLEQUE, *February 17, 1886.*

INTERROGATORIES CONCERNING CHOLERA IN TOWNS AND VILLAGES OF SPAIN, AND REPLIES,  
UNDER AUTHORITY OF THE SPANISH GOVERNMENT.\*

After my interrogatories already mentioned had been distributed by mail, I learned that some months previous the sanitary department of the Spanish Government had drafted and distributed among the health authorities of the Spanish populations invaded by cholera during 1885 a very similar series of questions. I became informed also upon inquiry that a large number of official replies to these interrogatories received by the Government had been turned over for classification and analysis to Dr. Philip Hauzer, of Madrid.

Desiring to profit by the valuable information embodied therein the writer succeeded, through the agency of the American minister and the Spanish minister of the interior, in effecting an agreement between himself and Dr. Hauzer to combine the information contained in these two sets of replies, have them analyzed in tabular form, and printed for more convenient study by themselves. The following is a translation of a pamphlet published at their expense conjointly in accordance with this agreement, and is introduced in this report on account of the original information it contains, in the hope that it may prove valuable to those desiring data as near as possible to original sources:

EPIDEMIOLOGICAL STUDIES RELATING TO THE ETIOLOGY AND PROPHYLAXIS OF CHOLERA  
BASED UPON VERY NUMEROUS FACTS AND AUTHENTIC DATA COLLECTED BY SEÑOR DON ARCADIO  
RODE, DIRECTOR OF CHARITIES AND HEALTH, DURING THE CHOLERA INVASION IN SPAIN. BY  
DR. PHILIP HAUZER, OF MADRID, 1886.

INTERROGATORIES RELATING TO THE CHOLERA EPIDEMIC OF 1885, ADDRESSED TO THE OFFICIAL AUTHORITIES AND  
PHYSICIANS OF THE PLACES INVADDED BY THE SAID EPIDEMIC.

- (1) What was the date of the commencement and termination of the cholera in each village?
- (2) How was the first case of cholera imported—by personal effects, or by persons proceeding from infected places?
- (3) What were the general hygienic conditions of the locality, especially as to the dwellings of the first attacked?

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\* Abstracts of official documents obtained through the courtesy of the Spanish Government.

(4) What system of sewerage has the town? What is the means of removal of filth? Who is charged with the cleaning of the town? Is it the municipality, or a contractor, or is service of this character entirely wanting?

(5) What kind of potable water supplies the town? Does it proceed from springs, from rivers, or from rain-water, and is it collected in cisterns or wells of unknown source? Is it regarded as of good quality, pleasant to the taste, hard or soft, containing lime or magnesia?

(6) Is it believed that the houses which have constituted foci have been supplied with water supposed to be contaminated?

(7) What are the geological conditions of the town? Is the soil sandy, granitic, calcareous, or argillaceous? Is the town surrounded by marshes or ponds? Are intermittent fevers usually frequent? At what time of the year?

(8) At what distance from the town is the cemetery?

(9) Are the pipes which conduct the drinking water of terra-cotta, lead, or iron?

(10) During the previous epidemics did your towns suffer more or less than this time? If the epidemic did not visit your town, to what is your escape attributed?

(11) Is your town situated upon a river, a stream, or at the confluence of several?

(12) In what degree was the part of the town nearest the river affected in comparison to the more elevated sections?

(13) What means of communication between your town and other infected points existed? Were they by rail, by river, by sea, or by land?

(14) What preventive measures were employed—cordons and lazarettos, or disinfectants?

(15) Is the abuse of fruits and vegetables frequent? Which predominates—melons, prickly pears, or salads, etc.?

(16) What is the common manner of washing clothing—in public lavatories, in the streams or rivers, in special fountains, or in what other manner? Does the custom of giving the clothing out to wash predominate?

(17) How many days did the epidemic last? What was the length of the period of increase; what that of the height, and what that of the decline of the epidemic?

(18) Did the highest mortality coincide with days of storm and rain? How did storm and rain affect the course of the epidemic?

(19) Was the invasion of cholera preceded by a tendency to diarrhoeas or intestinal disturbances among the inhabitants?

(20) How many attacks occurred during the epidemic, classified by sex?

(21) Number of deaths classified in the same manner?

(22) How many attacks occurred in the lower stories; how many in the upper? How many in houses with northern exposure; how many in those with southern exposure?

(23) If there are military barracks or penal establishments in your locality, what was the proportion of mortality in them compared to that of the civil population?

(24) Express every circumstance that the local physicians deem worthy of being mentioned for a full understanding of the cholera epidemic, or for its history.

#### REPLIES FROM TOWNS IN THE PROVINCE OF VALENCIA.

*Vallés, 265 inhabitants.*—(1st answer.) From the 1st of March to the 2d of July. (2d) By persons and effects, mainly the latter. (3d) Both good. (4th) There is none; the inhabitants do the cleaning. (5th) Good, hard, pleasant well-water. (6th) No. (7th) Clay; there are no marshes, neither are fevers frequent. (8th) At more than 1 kilometer. (9th) There are none; only an open canal  $1\frac{1}{2}$  meters wide. (10th) Suffered more in the former. (11th) At 20 meters distance from the river. (12th) Equally. (13th) Neighboring roads. (14th) None. (15th) No one abstained from fruits. (16th) In the irrigation canal or river. (17th) More than 110 days. (18th) After a few days of rain the first attacks occurred. (19th) Yes. (20th) 8 attacks. (21st) 4 deaths. (22d) In the lower. (23d) There are none.

*Manuel, 1,585 inhabitants.*—(1st answer.) From the 28th of March to the 18th of July. (2d) By persons from Játiva. (3d) The first good, the second medium. (4th) There is none;



the inhabitants do the cleaning. (5th) Well and spring water; good. (6th) No. (7th) Sand and clay; there are artificial marshes for the cultivation of rice; fevers from April to October. (8th) At 560 meters. (9th) There are none. (10th) Suffered most in the former. (11th) Near the river Albroida. (12th) No difference noted. (13th) Railroads and pikes. (14th) Disinfectants. (15th) Yes. (16th) In the brook and river. (17th) 113 days; irregular march. (18th) Not noted. (19th) Yes. (20th) 54 attacks—17 males, 37 females. (21st) 23 deaths—5 males, 18 females. (22d) Not observed. (23d) There are none.

*Rotgla y Corberá*, 858 inhabitants.—(1st answer.) From the 19th of April until the 12th of July. (2d) Unknown. (3d) Hygienic condition of both good. (4th) There is no sewerage. (5th) River water collected in cisterns; healthy and good. (6th) No. (7th) Clay; no marshes but frequent fevers. (8th) At 500 meters. (9th) There are none. (10th) Not attacked before. (11th) No. (12th) Equally. (13th) Cart roads and pikes. (14th) Disinfectants. (15th) Cante-loupes. (16th) In the irrigation canals at the border of the village. (18th) No. (20th) 13 attacks. (21st) 12 deaths.

*Catarroja*, 5,521 inhabitants.—(1st answer.) From the 1st of May to the 24th of July. (2d) By persons from Sueca and Cuellera. (3d) Both ordinary. (4th) There is none; inhabitants do the cleaning. (5th) There are wells in all the houses; water contains lime. (6th) No. (7th) Clay; one hour distant from Albufera; mild fevers in spring and autumn. (8th) At 500 meters after the cholera; before, near the village. (9th) There are none. (10th) The former less severe. (11th) Near a canal proceeding from Cheste Glura. (12th) The part near the river three times more affected. (13th) Railroads and pike. (14th) Disinfectants and isolation. (15th) Yes. (16th) In public lavatories whose water emptied into the river; use prohibited during cholera. (17th) 86 days—ascend, 59; apogee, 12; descent, 15. (18th) Yes. (19th) No; the first case of diarrhoea with characteristics of cholera. (20th) 587 attacks—217 males, 370 females. (21st) 336 deaths—123 males, 213 females. (22d) In the lower, and equally to the north and south. (23d) There are none.

*Gandia*, 7,604 inhabitants.—(1st answer.) From the 5th of May to the 16th of August. (2d) By persons from infected places. (3) The first good; the second bad. (4) There is none; streets cleaned by the inhabitants; the market places by the municipality. (5th) Well water; origin unknown; good. (6th) No. (7th) Clay and limestone; there are marshes 3 kilo-meters distant and fevers in the autumn. (8th) At 1 kilometer. (9th) There is none. (10th) The former less severe. (11th) Upon the river Serpis. (12th) Equally. (13th) Railroads and cart roads and neighboring lanes. (14th) Lazarettos and disinfectants. (15th) Have abstained. (16th) In the river and irrigation canals. (17th) 103 days—ascend, 15; apogee, 20; descent, 68. (18th) No. (19th) Yes. (22d) All in the lower. (23d) No one died in the prisons.

*Benigánim*, 3,184 inhabitants.—(1st answer.) From the 8th of May to the 21st of July. (2d) By rice harvesters proceeding from the banks of the Jucar. (3d) Both bad. (4th) The village is permeated by pipes which conduct the dirty water from the houses into a deep pit, and the latter communicates with the river Albaida. (5th) Good spring water, contaminated through the bad condition of the sewers. (6th) Yes; the part of the village most affected was supplied from a well in contact with a sewer. (7th) Clay and limestone; no marshes, but there are fevers in autumn. (8th) At 500 meters. (9th) Short and of brick. (10th) Except in 1854, the former were more severe. (11th) In the time of rains there are three brooks; the river Albaida is one-half kilometer distant. (12th) Equally. (13th) Cart roads. (14th) Cordons. (15th) Yes. (16th) In the public lavatory and in private basins. (17th) 74 days—ascend, 53; apogee, 10; descent, 11. (18th) Yes; for a few days after a storm there was a marked increase. (19th) No; the invasion was sudden. (20th) 812 attacks—363 males, 449 females. (21st) 253 deaths—113 males, 140 females. (22d) All in the lower; equally to the north and south. (23d) In a convent between two infected streets, there was not a single case.

*Alboraya*, 3,956 inhabitants.—(1st answer.) From the 20th of May to the 28th of July. (2d) By persons from Valencia. (3d) The first good; the second very bad. (4th) There is none; two

irrigation canals serve as sewers; there is no provision for cleaning. (6th) No. (7th) Sandy; there are two reservoirs for irrigation; fevers infrequent, some in autumn. (8th) A kilometer distant from the village. (9th) There is none. (10th) The former less severe. (11th) The village is traversed by irrigation canals. (12th) Equally. (13th) Railroads and pikes. (14th) Disinfectants and isolation. (15th) Yes. (16th) There is a public lavatory; customarily in the houses. (17th) 69 days—ascend, 25; apogee, 26; descent, 18. (18th) No. (19th) Yes. (20th) 424 attacks—149 males, 275 females. (21st) 183 deaths—60 males, 123 females. (22d) All in the lower; to the north, 168; to the south, 256. (23d) There are none.

*Benifaraig, 653 inhabitants.*—(1st answer.) From the 20th of May to the 17th of July. (2d) Unknown. (3d) Both medium; the second rather the worse. (4th) The whole village is a pool of filth. (5th) Bad well water. (6th) No. (7th) Sandy; tendency to fevers; more at the edge of the village than in the interior. (8th) At 500 meters. (9th) There is none. (10th) Equally. (11th) At 6 kilometers from the Laturia. (12th) At the edge of the town more cases than within it. (13th) Neighboring roads and pikes. (14th) Hygiene. (15th) Prudent in the use of fruits. (16th) Houses and in cisterns. (17th) 56 days—irregular march. (18th) Attacks increased with dampness. (19th) Yes. (20th) 44 attacks—19 males, 25 females. (21st) 35 deaths—17 males, 18 females. (22d) All in the lower; equally with respect to the winds. (23d) There are none.

*Alfará del Patriarca, 984 inhabitants.*—(1st answer.) From the 28th of May to the 28th of July. (2d) Unknown. (3d) The first good; the second ordinary. (4th) There is none; no municipal service; the inhabitants collect the excrement for manure. (5th) Well and cistern water from the river Moncata; water collected every year; good. (6th) Yes; first attacked lived near the irrigation canal, which passes through an infected place. (7th) Clay and sandy; no marshes, but fevers frequent in autumn. (8th) At 133 meters. (9th) Very ancient. (10th) The former less severe. (11th) Between a stream and the Moncata irrigation canal. (12th) Equally. (13th) Neighboring roads. (14th) Disinfectants. (15th) Abstained this year. (16th) Each inhabitant in his house. (17th) 58 days—ascend, 6; apogee, 24; descent, 28. (18th) No; after the first case it rained. (19th) No. (20th) 69 attacks—27 males, 42 females. (21st) 39 deaths. (22d) All in the lower; equally with respect to the winds. (23d) There are none. (24th) In this and former epidemics there were cases of intermittent fevers.

*Anna, 1,888 inhabitants.*—(1st answer.) From the 29th of May to the 19th of June. (2d) Unknown. (3d) The first excellent; the second bad. (4th) There is none; cleaning by the municipality. (5th) Spring water, containing iron. (6th) No. (7th) Limestone and clay; no marshes; fevers in September among the rice harvesters. (8th) In the village. (9th) There are none, except ditches and canals. (10th) Equally. (11th) Upon the river Sellent. (12th) The highest part suffered most. (13th) Pikes. (14th) All three. (15th) Yes. (16th) In public lavatories and in the houses. (17th) 22 days; irregular march. (18th) Yes. (19th) Yes. (20th) 69 attacks—33 males, 36 females. (21st) 22 deaths—9 males, 13 females. (22d) Not observed. (23d) There are none. (24th) More contagious than in other epidemics.

*Loriguilla, 149 inhabitants.*—(1st answer.) From the 17th of July to the 1st of August. (2d) Unknown. (3d) Both bad. (4th) There is none; cleaning left to the inhabitants. (5th) River water. (6th) Unknown. (7th) Sand and granite; no marshes nor fevers. (8th) 150 meters. (9th) There is none. (10th) Former less than this. (11th) On the banks of the Laturia. (12th) Equally. (13th) By land communications. (14th) All three. (15th) Yes. (16th) In ponds at a half-league distance. (17th) 17 days—ascend, 7; apogee, 5; descent, 5. (18th) Rain at the beginning. (19th) Yes. (20th) 52 attacks—18 males, 34 females. (21st) 27 deaths—10 males, 17 females. (22d) All in the lower; 30 to the north, and the rest to the south. (23d) There are none.

*Algar, 769 inhabitants.*—(1st answer.) From the 4th of June to the 1st of August. (2d) Unknown. (3d) The first ordinary; the second bad. (4th) There is none; inhabitants clean. (5th) Water from the river Palencia collected in cisterns; good. (6th) Unknown. (7th) Sandy and limestone; no marshes, but there is a pool; autumnal fevers; the pool is considered unhealthy. (8th) At 12 meters from the village. (9th) Of brick. (11th) Upon the river



Palencia at its confluence with a large stream. (12th) 25 per cent. more in the part near the river. (13th) By land. (14th) Cordons and lazarettos. (15th) In the canal, but at fixed hours. (17th) 56 days—ascend, 21; apogee, 13; descent, 22. (18th) No. (19th) Yes. (20th) 72 attacks—28 males, 44 females. (21st) 22 deaths—9 males, 13 females. (22d) In the lower; 30 in the upper. (23d) There are none.

*Villanueva del Grao*, 4,438 inhabitants.—(1st answer.) From the 5th of June to the 3d of August. (2d) Unknown. (3d) The first good; the second fair. (4th) Large sewers; municipality removes dirt with carts. (5th) Filtered river Turia water; pleasant; contains lime. (6th) No. (7th) Limestone; no marshes; fevers frequent in autumn. (8th) At 70 meters. (9th) Iron pipes. (10th) Equally. (11th) Upon the river Turia; at the southwest and southern part is the sea. (12th) As four to five. (13th) By railroads, and by sea and land. (14th) Disinfectants. (15th) No; a predominance of canteloupes and peppers. (16th) In the public lavatories. (17th) 60 days. (18th) No. (19th) No. (20th) 211 attacks—86 males, 125 females. (21st) 105 deaths—33 males, 72 females. (22d) Unknown. (23d) There are none.

*Malsafasar*, 694 inhabitants.—(1st answer.) From the 1st of June to the 24th of July. (2d) Unknown; the first case in a woman of the village without contact with an infected person. (3d) Both good. (4th) There is none; inhabitants clean. (5th) Spring water; good. (6th) No. (7th) Sand and clay; no marshes, but there are rice plantations near; intermittent fever all the year, increasing in autumn. (8th) Near the village. (9th) There is none. (10th) Former less grave. (11) In a dry location; the nearest river is at an hour and a half distance. (13th) Railroads and neighboring roads. (14th) Disinfectants and general cleaning. (15th) Yes; much of all. (16th) In public lavatories. (17th) 50 days—ascend, 16; apogee, 8; descent, 26. (18th) Yes; the greatest mortality coincided with a storm. (19th) Yes. (20th) 116 attacks—56 males, 60 females. (21st) 62 deaths—30 males, 32 females. (22d) In the lower, 114; to the north, 62; to the south, 54. (23d) There are none.

*Tous*, 1,573 inhabitants.—(1st answer.) From the 13th of June to the 23d of August. (2d) By persons. (3d) First good; second bad. (4th) There is none; defecation in the streets and squares; cleaning by contract. (5th) Good spring water, containing lime and magnesia. (6th) No. (7th) Granite; no marshes, but the Júcar River adjoins the town; fevers the whole year; more in autumn. (8th) At 300 meters. (9th) Of brick. (10th) The last more severe. (11th) The Júcar River laves the walls of the houses. (12th) Equally. (13th) Small roads; no highways. (14th) Cordons and disinfectants on a large scale. (15th) Of fruits, no; of vegetables, yes. (16th) Ordinarily in the Júcar. (17th) 71 days—ascend, 27; apogee, 24; descent, 20. (18th) No. (19th) Yes; there were 424 cases of diarrhoea during the epidemic. (20th) 45 attacks—27 males, 18 females. (21st) 30 deaths—12 males, 18 females. (22d) All in the lower; 17 to the north and 25 to the south. (23d) There are none.

*Bugarra*, 1,306 inhabitants.—(1st answer.) From the 16th of June to the 9th of August. (2d) By persons. (3d) First ordinary; second bad. (4th) There is none; excrement emptied into portable vessels for manure; the inhabitants clean. (5th) Spring and river water; pleasant to the taste; chloride of sodium and carbonate of lime. (6th) No. (7th) Limestone and clay; no marshes; few fevers in autumn. (8th) At 800 meters. (9th) There is none. (10th) The former more severe. (11th) Upon the banks of the Turia. (12th) The part next to the river suffered twice as much. (13th) Neighboring roads. (14th) Cordons and disinfectants. (15th) Yes. (16th) In the public lavatory, which is at the river. (17th) 56 days—ascend, 6; apogee, 8; descent, 42. (18th) Two days after rain the epidemic developed; the greatest mortality coincided with rain. (19th) Yes. (20th) 64 attacks—45 males, 19 females. (21st) 36 deaths—24 males, 12 females. (22d) 47 in the lower and 17 in the upper; 35 to the north, 29 to the south. (23d) There are none.

*Yátova*, 1,745 inhabitants.—(1st answer.) From the 23d of June to the 31st of July. (2d) By persons. (3d) First ordinary; second miserable. (4th) There is none. (5th) Springs, good, containing magnesia. (6th) Yes. (7th) Clay and limestone; no marshes nor fevers. (8th) At 1 kilometer. (9th) Of brick. (10th) More this time. (13th) Highways. (14th) All three. (15th) Yes. (16th) In lavatories and in canals. (17th) 38 days—ascend, 13; apogee, 4;

descent 21. (18th) Yes. (19th) Yes. (20th) 232 attacks—123 males, 109 females. (21st) 72 deaths—32 males, 40 females. (22d) All in the lower; equally to the north and south. (23d) There are none.

*Ayelo*, 2,883 inhabitants.—(1st answer.) From the 13th to the 31st of July. (2d) Unknown. (3d) First good; second bad. (4th) There is none; inhabitants clean. (5th) Good; water from the mountain. (6th) No. (7th) Clay; no marshes nor fevers. (8th) At 1 kilometer. (9th) There is none. (10th) First epidemic this time. (11th) No river near. (12th) Equally. (13th) Neighboring roads. (14th) All three. (15th) Prohibited. (16th) In running water, which empties into a pool. (17th) 27 days—ascend, 8; apogee, 8; descent, 11. (18th) Yes. (19th) Yes. (20th) 25 attacks—6 children, 12 men, 7 old women. (21st) 14 deaths—3 children, 4 men, 7 women. (22d) All in the lower; almost all to the south. (23d) There are none.

*Bugat*, 176 inhabitants.—(1st answer.) From the 15th of July to the 2d of August. (2d) Unknown. (3d) Both bad. (4th) There is none; deposited in the court-yards. (5th) Water from the neighboring mountain; good. (6th) No. (7th) Clay; no marshes nor fevers. (8th) At 1 kilometer. (10th) This attack the first. (11th) At the foot of the mountain; no river. (12th) Equally. (13th) Neighboring roads. (14th) All three. (15th) Prohibited. (16th) In running water. (17th) 19 days—ascend, 10; apogee, 4; descent, 5. (18th) Yes. (20th) 32 attacks—3 children, 16 men, 13 aged. (21st) 19 deaths—4 children, 8 men, 7 aged. (22d) All in the lower; majority to the north. (23d) There are none.

*Chirivella*, 1,165 inhabitants.—(1st answer.) From the 21st of May to the 24th of July. (2d) By persons. (3) Both bad. (4th) There is none; inhabitants clean. (5th) Well water, which can be contaminated by excrementitious material. (6th) Suspected. (7th) Huerta of Valencia; much irrigation water; malaria frequent. (8th) At 250 meters. (9th) There is none. (10th) This time less than the last. (11th) Between the river Turia and the bed of a stream. (12th) Unknown. (13th) By land. (14th) Disinfectants. (15th) No. (16th) In canals and in well water. (17th) 50 days—ascend, 20; apogee, 10; descent, 20. (18th) No. (19th) Unknown. (20th) 285 attacks—84 males, 201 females. (21st) 45 deaths—21 males, 24 females. (22d) Equally. (23d) There are none.

*Bocairente*, 4,261 inhabitants.—(1st answer.) From the 20th of July to the 19th of September. (2d) Supposed by persons. (3d) Both bad. (4th) There is none; inhabitants clean. (5th) Spring water; good, containing lime. (6th) No. (7th) Calcareous soil; no marshes nor fevers. (8th) At 1 kilometer. (9th) Of brick and zinc. (10th) Anterior less severe. (11th) Village on the top of a hill. (13th) Railroads and narrow roads. (14th) All three. (15th) No. (16th) In public lavatories and canals outside of the houses. (17th) 62 days—ascend, 21; apogee, 7; descent, 34. (18th) Yes. (19th) No. (20th) 412 attacks—182 males, 230 females. (21st) 127 deaths—18 children, 81 adults, 28 aged. (22d) All in the lower and to the south. (23d) There are none.

*Torrebaia*, 728 inhabitants.—(1st answer.) From the 21st of July to the 4th of September. (2d) By persons. (3d) Both bad. (4th) There is none; the municipality undertakes the cleaning. (5th) River and fountain water; good. (6th) No. (7th) Granite; permeated by rivers and springs; no intermittent fevers. (8th) At 500 meters. (9th) There is none. (10th) Same as this. (11th) Between two rivers. (12th) Equally. (13th) By land. (14th) All three. (15th) Yes. (16th) In the rivers. (18th) After a storm. (19th) Diarrhoeas. (20th) 41 attacks—11 adults, 16 aged, 14 children. (21st) 41 deaths. (22d) Generally in the lower. (23d) There are none.

*Oliva*, 7,410 inhabitants.—(1st answer.) From the 16th of June to the 30th of July. (2d) By persons. (3d) Both bad. (4th) There is none; inhabitants clean. (5th) Spring and well water; both bad. (6th) It is possible. (7th) Surrounded by marshes; there is much fever. (8th) At 1 kilometer. (9th) There is none. (10th) Anterior, worse. (11th) No river near. (13th) Railroads and narrow roads. (14th) Nothing. (15th) Yes. (16th) In public lavatories. (17th) 45 days—ascend, 8; apogee, 12; descent, 25. (18th) Yes. (19th) Yes. (20th) 242 attacks—106 males, 136 females. (21st) 116 deaths. (22d) Majority in the lower. (23d) There is none.



*Camporrobes*, 1,410 inhabitants.—(1st answer.) From the 1st of August to the 18th of September. (2d) By persons. (3d) First good; second bad. (4th) There is none. (5th) Springs; good; containing magnesia. (6th) No. (7th) Clay; infrequent fevers. (8th) At 300 meters. (9th) There is none. (10th) Equally. (11th) There is a reservoir; marshes near the village. (12th) Near the reservoir the worst. (13th) Neighboring roads. (14th) All three. (15th) Yes. (16th) In the reservoir; outside the houses. (17th) 49 days—ascend, 23; apogee, 10; descent, 16. (18th) Yes. (19th) Yes. (20th) 190 attacks—28 children, 92 women, 70 men. (21st) 54 deaths—26 women, 18 men, 10 children. (22d) In the lower, and to the south. (23d) There are none.

*Ayora*, 4,905 inhabitants.—(1st answer.) From the 25th of August to the 20th of October. (2d) Supposed by persons. (3d) First good; second ordinary; first case in the station of the civil guard. (4th) There is none; inhabitants clean the sinks when they are full; public cleaning by the inhabitants. (5th) Good spring and well water, containing magnesia. (6th) No. (7th) Limestone and clay; no marshes or frequent fevers. (8th) At 500 meters. (9th) Of brick and iron. (10th) Former worse. (11th) No rivers or streams. (13th) By land. (14th) All. (15th) Yes. (16th) In public lavatories. (17th) 55 days—ascend, 12; apogee, 8, descent, 35. (18th) No. (19th) Yes. (20th) 133 attacks—48 males, 85 females. (21st) 56 deaths—26 males, 30 females. (22d) All in the lower; equally to the north and south. (23d) In the prison of the district there was no case.

*Llauré*, 954 inhabitants.—(1st answer.) From the 7th of May to the 26th of July. (2d) Unknown; the first attack was after a debauch. (3d) Bad; the second, damp. (4th) There is none; deposited in tanks, afterwards removed to the fields; no cleaning of the village. (5th) Wells or streams; bad; containing limé. (7th) Clay; no marshes; much fever in the spring and autumn. (8th) At 1 kilometer. (9th) There is none. (10th) Anterior less severe. (11th) Surrounded and traversed by streams of rapid current. (12th) Equally. (13th) By land. (14th) Nothing. (15th) Yes. (16th) In the streams and canals. (17th) 80 days—ascend, 40; apogee, 25; descent, 15. (18th) On the following day. (19th) Yes. (20th) 300 attacks—111 males, 189 females. (21st) 78 deaths—27 males, 51 females. (22d) Houses only one story.

*Llosa de Ranes*, 2,034 inhabitants.—(1st answer.) From the 14th of May to the 19th of June. (2d) Communication with Játiva. (3d) Ordinary. (4th) Deposited in the court-yards, and mixed with straw to form manure. (5th) Springs on a hill; pleasant and good. (6th) Unknown. (7th) Granite; no marshes nor fevers. (8th) Within the village, and bad. (9th) Of brick. (10th) More this time. (11th) No. (13th) Neighboring roads and highways. (14th) Hygiene; interruption of communication with other villages; disinfectants. (15th) Not during the epidemic. (16th) In the public lavatories, whose water is changed every day; those of the sick in a special one outside of the village. (17th) 60 days—ascend, 16; apogee, 34; descent, 10. (18th) Increased with clouds and dampness. (19th) Yes. (20th) 109 attacks—39 males, 70 females. (21st) 67 deaths—25 males, 42 females. (22d) Upper stories, 8; lower, 101; to the north, 30; to the south, 79.

*Buñol*, 4,173 inhabitants.—(1st answer.) From the 30th of May to the 25th of July. (2d) By persons from infected places. (3d) First good; second bad. (4th) There is none; each person collects the filth under the direction of the municipality. (5th) Springs and neighboring fountains; good; pleasant; contains lime, and is hard. (6th) No. (7th) Granite; no marshes nor fevers. (8th) At 652 meters. (9th) Of brick. (10th) More this time. (11th) At the confluence of several streams and a small river. (12th) Equally. (13th) Highways and roads. (14th) Cordons, lazarettos, disinfectants, and isolation. (15th) No. (16th) In public lavatories and in streams; also in the houses. (17th) 47 days—ascend, 14; apogee, 8; descent, 25. (18th) Yes; followed. (19th) No. (20th) 484 attacks—208 males, 276 females. (21st) 277 deaths—137 males, 140 females. (22d) Upper stories, 7; lower, 477; to the north, 206; to the south, 278. (24th) In damp houses there were more attacks.

*Bétera*, 2,610 inhabitants.—(1st answer.) From the 27th of May to the 16th of August. (2d) By persons from infected places. (3d) Both bad. (4th) There is none; carried to the fields by regulation of the authorities. (5th) Wells, springs, and fountains; good. (6th) No.

(7th) Clay; no marshes nor fevers. (8th) At 950 meters. (9th) There is none. (10th) Less than in former epidemics; none in 1865. (11th) Rivers and streams. (12th) 80 per cent. more. (13th) By land. (14th) Believing cordons to be inadvisable, disinfectants and isolation of the sick poor, who were removed to the hospital, and closing their dwellings, were employed. (15th) No. (16th) In the irrigation canal, and when clothing was suspected, it was washed in the lower part of the same. (17th) 85 days. (18th) Coincided at times with rain. (19th) No. (20th) 170 attacks—61 males, 109 females. (21st) 97 deaths—35 males, 62 females. (22d) Houses all one story.

*Jalance*, 1,811 *inhabitants*.—(1st answer.) From the 11th of July to the 20th of August. (2d) By a person who drank from the river Júcar, which was infected. (3d) Both bad. (4th) There is none; the village is on sloping ground; the municipality has charge of cleaning. (5th) From the river Júcar; prohibited and spring water used. (6th) Unknown. (7th) Limestone; no marshes and fevers only in autumn. (8th) At 50 meters. (9th) There is none. (10th) Equally. (11th) Upon the banks of the river Júcar and at 100 meters above it. (13th) Small roads and by water. (14th) All. (15th) Abuse of fruits, especially canteloupes, watermelons, and grapes. (16th) In the river Júcar. (17th) 42 days. (18th) No. (19th) Yes; 15 to 20 days before. (20th) 94 attacks—46 males, 48 females. (21st) 47 deaths—20 males, 27 females.

*Alcira*, 16,000 *inhabitants*.—(1st answer.) From the 29th of May to the 1st of August. (2d) Imported by a person from an infected place and living in the house of the first victim. (3d) Bad. (4th) There is none; deposited in the court-yards, which are flooded by the rains, and empty into the river Júcar. (5th) River Júcar water, wells, and springs. (6th) Probably that of the Júcar. (7th) Sandy; very porous; surrounded by marshes; malarial fevers frequent; rain is rare during summer. (9th) No sewers. (11th) Upon the river Júcar. (12th) Part near the river more severe than the upper part. (13th) Railroads and highways. (14th) No cordons, but disinfectants, especially for the dejections of cholera patients; inoculation of Ferrán. (15th) Abuse of fruits, canteloupes, and watermelons. (16th) In the river which traverses the city through its center. (17th) 124 days—ascend, 63; apogee, 40; descent, 21. (18th) No. (20th) 457 attacks—214 males, 243 females. (21st) 208 deaths—95 males, 113 females. (22d) No statistics. (23d) No statistics. (24th) The first cases occurred in persons who used the Júcar water, which use was suppressed for the city after the epidemic was established.

*Liria*, 9,445 *inhabitants*.—(1st answer.) From the 22d of June to the 29th of August. (2d) Persons from infected places; their effects disseminated by sale. (3d) Both bad. (4th) No sewers; except for the storm water. (5th) Springs of good quality. (6th) No. (7th) Chalky soil and alluvium. (9th) Upon a canal filled with organic matter. (11th) There is a hill at 2 kilometers from the village. (13th) By land. (14th) Isolation and fumigations at the beginning; afterwards nothing, on account of the rapidity of its propagation. (17th) 60 days. (20th) 598 attacks—268 males, 330 females. (21st) 414 deaths—186 males, 228 females.

*Fuente Encarroz*, 2,122 *inhabitants*.—(1st answer.) From the 3d of May to the 11th of July. (2d) First attacks were neighbors from infected places. (3d) Both bad. (4th) There is none. (5th) Spring water; irrigation by river water; no village above was attacked before. (7th) The subsoil tertiary; the soil is fertile and constantly moist. (10th) This epidemic more severe than former. (11th) Upon the river Serpis; it is near the sea. (13th) By land. (14th) Cordons at the beginning; isolation and fumigations afterwards. (15th) Abuse of fruits in general and during the epidemic the use of those of bad quality prohibited. (16th) The public lavatories within the village. (17th) 61 days—ascend, 39; apogee, 11; descent, 11. (18th) Yes; the apogee coincided with a storm, rain, and heat; temperature, 40° C. (19th) Yes. (20th) 481 attacks—221 males, 260 females. (21st) 176 deaths. (22d) Those to the south most affected. (24th) During March and April hygienic measures were adopted, especially with respect to cleaning of the houses, drinking water, and public lavatories.

*Carlet*, 4,467 *inhabitants*.—(1st answer.) From the 18th of June to the 4th of August. (2d) Supposed to be imported from Aleira by agricultural laborers who were in contact with infected persons. (3d) Both bad. (4th) There is none; in ordinary times, no cleaning; during the epidemic hygienic measures and disinfection of the streets and houses were adopted. (5th)



Good spring water, containing lime. (6th) No. (7th) Soil silicious, porous, and calcareous. (11th) Upon the river Magro; from this irrigation canals depart, running through the town; the cholera followed a march inversely to the current of the river. (13th) Railways and roads to Alcira. (14th) Cordons at the beginning; disinfectants and hygienic measures afterwards. (17th) 48 days. (19th) Was preceded by gastric troubles. (20th) 280 attacks—162 males, 118 females. (21st) 93 deaths—34 males, 59 females. (22d) In former epidemics the cholera appeared in time to disappear in the winter; this time it appeared in the spring and disappeared in the summer (autumn). (24th) Probably the state of exceptional moisture, on account of abundant rains this year, was a favorable cause for the development of cholera in the province of Valencia.

*Mogente*, 4,171 *inhabitants*.—(1st answer.) From the 17th of May to the 29th of July. (2d) Imported by a youth, who, with two of his family, died. (3d) Both bad. (4th) There is none; the house drainage into sinks; deposited in the court-yards. (5th) Springs of good quality, dating from the time of the Moors; that of the river Albaida served for irrigation. (6th) No. (7th) Situated in a valley on the river Cañolas; very fertile; subsoil quaternary, lime. (9th) Of brick, dating from the time of the Moors. (10th) Always suffered much, although less severely than other neighboring villages. (11th) Upon the river Cañolas. (12th) The lower part near the river was most affected. (13th) Roads. (14th) All sorts of hygienic measures; cordons abandoned, because considered useless. (15th) During the epidemic great vigilance exercised to prevent their abuse, domiciliary visits being practiced. (16th) In the river. (17th) 73 days—ascend, 31; apogee, 12; descent, 30. (18th) Did not rain. (20th) 139 attacks—69 males, 70 females. (21st) 83 deaths—37 males, 46 females. (24th) Maximum mortality in general did not exceed 150; this year it reached 313.

*Ayelo de Malferit*, 2,965 *inhabitants*.—(1st answer.) From the 28th of June to the 31st of July. (2d) By a person arriving from an infected village. (4th) There is none. (5th) Neighboring springs; water for irrigation proceeds from an infected village up-stream. (7th) Quarternary; limestone rocks predominate. (9th) There is none. (11th) Near the river. (14th) Cordons and lazarettos which were inefficient. (17th) 34 days—ascend, 10; apogee, 5; descent, 19. (20th) 103 attacks—35 males, 68 females. (21st) 57 deaths—20 males, 37 females. (23d) There were whole streets infected by the epidemic; cause unknown. (24th) This year distinguished by an abundance of rains, more than others.

*Torrente*, 7,017 *inhabitants*.—(1st answer.) From the 29th of May to the 29th of June. (2d) By a youth proceeding from Valencia, already infected; no other village farther up-stream was then affected. (4th) Short and bad; house drainage into the streets; special provisions for cleaning. (5th) Good, spring. (6th) No. (9th) Conducted by a canal which is cleaned at least four times a year. (13th) By land. (14th) All kinds of hygienic measures, after being convinced that preventive measures caused panic and increased infections. (15th) Yes, in spite of great vigilance during the epidemic. (20th) 162 attacks—86 males, 76 females. (21st) 58 deaths—39 males, 19 females. (23d) Was not attacked in 1884, in spite of having frequent communication with invaded places.

*Foyos*, 1,318 *inhabitants*.—(1st answer.) From the 19th of May to the 25th of July. (2d) Unknown. (3d) Bad. (4th) No sewerage. (5th) Well water, which some subjected to boiling; irrigation by the Moncada Canal. (6th) The villages from which the irrigation water proceeded were not infected; one well suspected. (9th) There is none. (14th) Hygienic measures; fumigations without result; neither cordons nor lazarettos; sole measures, isolation and ventilation. (17th) 20 days—ascend, 8; apogee, 2; descent, 10. (20th) 81 attacks—24 males, 57 females. (21st) 42 deaths—19 males, 23 females. (24th) Two quarters most affected, on account of the houses being damp and pools surrounding them.

*Picaña*, 992 *inhabitants*.—(1st answer.) From the 5th of June to the 30th of July. (2d) Unknown; the first attacked had no communication with any suspected persons; it is supposed that it was brought from Valencia, already infected. (3d) Bad. (4th) There is none. (5th) Well and spring water; the last serves for irrigation and comes from a brook. (7th) The soil is porous; subsoil dry; limestone; exuberant vegetation. (9th) There is none. (12th) Suffered equally; mostly limited to persons with scanty and bad food. (14th) Disinfectants

and fumigations were used; no cordons nor quarantines. (16th) In basins outside the houses. (17th) 55 days. (20th) 18 attacks—8 males, 10 females. (21st) 10 deaths—4 males, 6 females. (24th) The greater part of the village is inhabited by workmen who labored in infected places.

## PROVINCE OF ALICANTE.

*Alicante*, 35,438 *inhabitants*.—(1st answer.) From the 1st of August to the 12th of September. (2d) By persons from infected places. (3d) Both ordinary. (4th) The greater part of the sewers empty into the port, which is never cleaned, producing a bad odor in summer; they have no water, and besides have no fall; imperfect cleaning. (5th) Good drinking water from springs; for household cleaning, use well water. (6th) No. (7th) Limestone, very porous. (8th) At 1 kilometer from the city, but this being full, a new one is being constructed. (9th) Of iron. (10th) In 1854 the number of attacks was more than a thousand; 1865, less; and in the last it reached only 400. (11th) Upon the sea-shore, and almost at its level. (12th) The upper part was severely attacked, where the inhabitants, mainly of the poorer classes, know nothing of principles of hygiene. (13th) Maritime, by land, and by rail. (14th) At the commencement, cordons, the effects of which were disagreeable, giving place to concealments, without preventing the moving of the sick entirely. (15th) The abuse of fruits and vegetables was watched with the greatest vigilance; on the contrary, there was much abuse of alcohol. (16th) In pools, or in canals outside of the city; in the well-to-do classes the washing was done within the houses, with well water. (17th) 42 days—ascend, 19; apogee, 8; descent, 15. (18th) Coincided with dampness and clouds. (20th) 400 attacks. (21st) 206 deaths. (22d) The greater part in the lower stories, particularly in the damp. (23d) No case in any public establishment; only one Sister of Charity and two of the Red Cross. (24th) In 1884 isolated cases occurred in the House of Beneficiencia y Maternidad, situated outside the walls. In March of 1885, during a night of snow-storm, five cases occurred.

*Novelda*, 8,839 *inhabitants*.—(1st answer.) From the 7th of June to the 9th of August. (2d) Unknown; (3d) Both bad. (4th) No sewers; defective cleaning. (5th) Spring water, besides a canal for irrigation coming from Elda, a neighboring town. (6th) No. (8th) Sandy and porous; fertile vegetation. (9th) There is none. (11th) At the foot of a mountain. (13th) Railroads. (14th) Almost nothing; fumigations in the square and streets. (20th) 192 attacks. (21st) 87 deaths.

*Villajoyosa*, 9,953 *inhabitants*.—(1st answer.) From the 21st of July to the 10th of September. (2d) Introduced by a girl who went to see her father at the lazaretto. (3d) Good conditions. (4th) No sewers; deposits in the court-yards. (5th) Good; springs; irrigation water from fountains. (6th) No. (8th) On account of the very heavy rains the soil is very moist. (9th) Of brick. (10th) Equally. (11th) Near the river Villa and the sea-shore. (12th) The portions near the river most affected. (13th) By sea and land. (14th) Cordons, lazarettos, and fumigations in the streets and houses attacked; negative results. (17th) 52 days—ascend, 18; apogee, 12; descent, 22. (20th) 706 attacks. (21st) 419 deaths.

*Villafranca*, 1,395 *inhabitants*.—(1st answer.) From the 21st of August to the 2d of September. (2d) By a sewage-cart, its owner being first attacked; neighboring villages infected. (3d) Both ordinary. (4th) There is none; it goes to the courts or to the streets. (5th) Springs. (6th) No. (8th) Very damp, on account of heavy rains. (14th) Almost nothing; fumigations at night in the streets and squares. (17th) 13 days. (20th) 31 attacks. (21st) 13 deaths.

*Catral*, 2,803 *inhabitants*.—(1st answer.) From the 20th of June to the 19th of August. (2d) By the use of infected water of the river Segura. (3d) Both bad. (4th) No sewerage; no cleaning; inhabitants deposit excrement in the courts for manure for fields. (5th) From the river Segura, which is used for irrigation, being conveyed every week; the aqueduct being dry for sixteen days; the water is collected in the winter months, and is kept in immense earthen jars after filtration. (6th) Most of the inhabitants used canal water after the infection of Murcia and Orihuela. (7th) Clay and marsh; surrounded by a large marsh, known as the Hondo; malarial fever everywhere. (8th) At 30 meters. (9th) There is none. (10th) Always



suffered greatly, and always invaded after the epidemic appeared in Murcia and Orihuela. (11th) Along the canal or aqueducts from the Segura. (12th) The part next the canal, 75 per cent. more attacked. (13th) By means of a canal, for there is not much communication by rail between Murcia and this village on account of the stations being 4 kilometers distant. (14th) Lazarettos, cordons, and disinfectants. (15th) Abuse of fruits and vegetables very prominent. (16th) In the surplus irrigation water; kept in a secondary aqueduct. (17th) 59 days—ascend, 18; apogee, 10; descent, 31. (18th) No. (19th) No. The epidemic developed suddenly with great force. (20th) 183 attacks—86 males, 97 females. (21st) 73 deaths—30 males, 43 females. (22d) Only 7 in upper stories; majority to the south. (23d) There are none. (24th) In the previous year, when there was cholera in the neighboring villages, as Elche, with which there was intimate communication, and in spite of the east wind which predominated, the disease did not enter this village, whilst Murcia and Orihuela, on account of the canal, had the greatest influence on the propagation of the disease.

*Dolores*, 2,555 inhabitants.—(1st answer.) From the 26th of June to the 22d of July. (2d) By water from the river Segura. (3d) First good; second bad. (4th) There are three sewers; public cleaning at the charge of the municipality. (5th) From the river Segura. (6th) Yes. (7th) Clay and sand; malarial fevers frequent; slight elevation above the sea. (8th) At 500 meters. (9th) There is none. (10th) Equally. (11th) At the confluence of various streams. (12th) Equally. (13th) By rail and highways. (14th) Disinfectants. (15th) Canteloupes and watermelons. (16th) In the canals and outside the houses. (17th) 30 days—ascend, 10; apogee, 5; descent, 15. (18th) Yes; two or three days from the apogee. (19th) Yes. (20th) 53 attacks. (21st) 17 deaths. (22d) Greater part in the lower; 20 to the south and 14 to the north; 12 to the west and east.

*Almoradí*, 3,629 inhabitants.—(1st answer.) From the 25th of June to the 8th of September. (2d) It is believed by infected clothing and by drinking water from the Segura. (3d) Both miserable. (4th) There is none; everything is abandoned in this village. (5th) Segura water, collected in large earthen jars; it contains lime. (6th) Yes. (7th) Clay; surrounded by large marshes, and fevers are perpetual. (8th) At 60 meters. (9th) There is none. (10th) Almost the same. (11th) At 2 kilometers from the Segura. (12th) Equally. (13th) All. (14th) All. (15th) Yes. (16th) In the canals and in pools. (17th) 76 days—ascend, 14; apogee, 11; descent, 51. (18th) Yes. (19th) Yes. (20th) 82 attacks—42 males, 40 females. (21st) 41 deaths—23 males, 18 females. (22d) All in the lower, and indifferently to the northwest, south, and west. (23d) There are none.

*Almudaina*, 493 inhabitants.—(1st answer.) From the 29th of June to the 26th of July. (2d) Unknown, but supposed to be imported. (3d) First good; second bad. (4th) There is none; inhabitants clean. (5th) Good spring water, containing lime. (6th) No. (7th) Sand and granite; never suffered from fevers. (8th) At 500 meters. (9th) There is none. (10th) Anterior, light. (11th) There are no rivers nor streams. (13th) Highways. (14th) Cordons and disinfectants. (15th) Yes. (16th) In public lavatories, with a small quantity of dirty water generally. (17th) 28 days—ascend, 10; apogee, 10; descent, 8. (18th) No. (19th) Yes. (20th) 69 attacks—27 males, 42 females. (21st) 30 deaths—12 males, 18 females. (22d) All in the lower. (23d) There are none. (24th) Bad vegetable food and want of cleanliness.

*Villena*, 11,424 inhabitants.—(1st answer.) From the 6th of July to the 16th of August. (2d) Unknown; two cases in a store which received goods from an infected place, but they were not the first cases. (3d) First good; second bad. (4th) There is none; inhabitants clean. (5th) Good spring water. (6th) No. (7th) Good; sandy clay, no marshes; few fevers. (8th) At 1,500 meters. (9th) Iron during a short part of the course; the rest of stone. (10th) The greatest was in 1834. (11th) Near a lake called Manto. (12th) The part most remote from this was most attacked. (13th) By rail and highways. (14th) All. (15th) No. (16th) In public lavatories at a half an hour from the village. (17th) 41 days—ascend, 16; apogee, 6; descent, 19. (18th) Yes. (19th) No. (20th) 1,098 attacks—475 males, 623 females. (21st) 531 deaths—221 males, 310 females. (22d) Unknown. (23d) There are none.

*Petrel*, 3,123 inhabitants.—(1st answer.) From the 6th of July to the 29th of August. (2d) Imported. (3d) First good; second bad. (4th) No sewers: cleaning by the municipality.

(5th) Good springs. (6th) No. (7th) Clay; no marshes nor fevers. (8th) At 200 meters. (9th) Of brick. (10th) Equally. (11th) Upon a stream. (12th) Part next the stream most attacked. (13th) By land. (14th) Cordons, houses of observation, disinfectants, carbolic acid, and sulphate of copper. (15th) Abuse of fruits and vegetables. (16th) Outside of the houses. (17th) 33 days—ascend, 10; apogee, 5; descent, 18. (18th) Coincided with storms and rains. (19th) No. (20th) 299 attacks—99 males, 200 females. (21st) 89 deaths. (22d) In the lower stories; 95 to the south and 104 to the north. (23d) In the post of the civil guard no cases occurred. (24th) Those who were prudent in diet escaped.

*Benilloba*, 1,429 inhabitants.—(1st answer.) From the 11th of July to the 18th of August. (2d) Supposed that persons coming from infected points imported it. (3d) Both bad. (4th) There is none; inhabitants clean. (5th) Good springs, containing magnesia. (6th) No. (7th) Sandy clay; the river Penaguila surrounds it; there are no fevers. (8th) At 200 meters. (9th) A leaden pipe. (10th) That of 1855 was greater. (11th) On the river at 30 meters altitude, upon a hillside. (12th) The higher part and that removed from the river suffered most. (13th) Highways and narrow roads. (14th) All. (15th) No. (16th) In the public lavatories. (17th) 38 days—ascend, 12; apogee, 15; descent, 11. (18th) No. (19th) No. (20th) 246 attacks—117 males, 129 females. (21st) 61 deaths—27 males, 34 females. (22d) All in the upper and equally as to winds. (23d) There are none. (24th) During the north wind clouds prevailed and the epidemic increased; diminished with the south wind.

*Lorcha*, 1,394 inhabitants.—(1st answer.) From the 14th of July to the 5th of August. (2d) Imported. (3d) Both bad. (4th) There is none; cleaning in charge of the municipality. (5th) Springs and wells supplied from the river Serpis; good quality and contains magnesia. (5th) No. (7th) Granite; no marshes nor malarial fevers. (8th) At 140 meters. (9th) No pipes; only canals. (10th) That of 1855 was greater. (11th) At the foot of a table-land and at the margin of the river Serpis. (12th) The higher part suffered more than near the river. (13th) Pathways. (14th) Cordons, lazarettos, and disinfectants. (15th) All kinds frequent. (16th) In public lavatories and running water. (17th) 22 days—ascend, 10; apogee, 8; descent, 4. (18th) During cloudy days the mortality increased. (19th) Yes. (20th) 88 attacks. (21st) 16 deaths. (22d) All in the lower stories, since there are no upper; the majority to the north. (24th) Attacked by preference the weak, the needy, and the laborers.

*Sella*, 1,796 inhabitants.—(1st answer.) From the 17th of July to the 4th of August. (2d) Supposed to be due to abuse in eating. (3d) The first good; the second fair. (4th) There is none; inhabitants clean. (5th) Good spring water. (6th) No. (8th) At 1,000 meters. (9th) There is none. (10th) Unknown. (11th) No river or stream. (13th) By land. (14th) All. (15th) Little. (16th) In public lavatories. (17th) 19 days—ascend, 8; apogee, 3; descent, 8. (18th) No. (19th) No. (20th) 45 attacks—18 males, 27 females. (21st) 18 deaths—7 males, 11 females. (22d) All in the lower; equally to the north and south. (23d) There are none.

*Denia*, 8,623 inhabitants.—(1st answer.) From the 25th of July to the 11th of August. (2d) It is suspected by persons from other infected points. (4th) There is no sewerage; excrement deposited in the courts; cleaning by the inhabitants. (5th) Wells; good and abundant. (6th) No. (7th) Subsoil, sandy and granite; soil moist; malaria constant. (8th) At 1,000 meters. (9th) Iron pipes. (10th) Former more severe. (11th) A sea-port. (13th) Maritime, highways, and railways. (14th) Cordons, lazarettos, and disinfectants. (15th) Yes. (16th) In the canals. (17th) 23 days—ascend, 6; apogee, 4; descent, 12. (18th) Yes. (19th) Yes. (20th) 128 attacks—58 males, 70 females. (21st) 83 deaths—38 males, 45 females. (22d) Almost all in the lower; to the north 100, and to the south 28. (23d) There are none. (24th) With assistance and good food the epidemic diminished.

*Elche*, 19,636 inhabitants.—(1st answer.) From the 26th of July to the 8th of September. (2d) Unknown; the first attacks had no communication; there was cholera in neighboring places. (3d) First good; second fair. (4th) There is none; there is a canal which collects the sewage; the inhabitants clean. (5th) Good spring water and rain water, containing magnesia. (6th) No. (7th) Limestone and clay; there is a marsh at a league's distance; fevers in autumn. (8th) At 1 kilometer. (9th) Of stone and wood. (10th) Anterior more severe. (11th) Upon



the river Vinalapó. (12th) Unknown. (13th) Railroads and highways. (14th) All, including cordons and lazarettos. (15th) Yes. (16th) In public lavatories and canals. (17th) 43 days—ascend, 5; apogee, 8; descent, 30. (18th) Coincided more with the descent. (19th) Yes. (20th) 67 attacks—24 males, 43 females. (21st) 32 deaths—10 males, 22 females. (22d) In the lower, 64; in the upper, 3; to the north, 27; to the south, 40. (23d) There are none.

*Cañada*, 762 inhabitants.—(1st answer.) From the 26th of July to the 19th of August. (2d) Unknown. (3d) Good. (4th) There is none; no public cleaning. (5th) Good springs. (6th) No. (7th) Limestone; no marshes nor fevers. (8th) At 1 kilometer. (9th) Cement. (10th) Former more severe. (11th) At the foot of a mountain. (13th) Highways and narrow roads. (14th) All. (15th) No. (16th) Running water. (17th) 24 days—ascend, 12; apogee, 4; descent, 8. (18th) Yes. (19th) Yes. (20th) 60 attacks—20 males, 40 females. (21st) 60 deaths—20 males, 40 females. (22d) All in the lower. (23d) There are none. (24th) There are no physicians.

*Hocheta*, 789 inhabitants.—(1st answer.) From the 23d of July to the 23d of August. (2d) Imported by the trappings of an ass, or by a trunk with soiled clothing which it carried. (3d) First good; second bad. (4th) There is none; each house is the deposit of excrement. (5th) Good spring water, containing lime and magnesia. (6th) The attacked used water of the river Sella, on the banks of which the population was attacked. (7th) Calcareous; there is a marsh; fevers are not very frequent. (8th) At considerable distance. (9th) There is no pipeage. (10th) Twice as severely attacked in the former. (11th) At the confluence of the rivers Amadores and Sella. (12th) The part next to the river was 5 per cent. more attacked. (13th) Highways and neighboring roads. (14th) Cordons and lazarettos. (15th) Yes. (16th) In the river and in public lavatories. (17th) 30 days—ascend, 10; apogee, 3; descent, 17. (18th) There was no rain; coincided with heavy clouds. (19th) Yes. (20th) 28 attacks—12 males, 16 females. (21st) 11 deaths—4 males, 7 females. (22d) All in the lower. (23d) There are none. (24th) The majority of the attacked were poor and dwelt in unhealthy houses.

*Alcoy*, 35,497 inhabitants.—(1st answer.) From the 27th of July to the 3d of September. (2d) Imported from neighboring villages. (3d) Good in the sections where the well-to-do lived; bad in the lower classes. (4th) Network of sewers, supplied by public fountains, emptying into the river. (5th) Good, abundant, and proceeding from springs. (6th) No. (7th) Clay; located upon a hill with a steep declivity; no marshes nor fevers. The rivers have a rapid current and supply power to many factories. (8th) At 50 meters, the old one; the new one at 2 kilometers. (9th) All iron; connected with a reservoir in the high part of the city. (10th) This time less. (11th) At the confluence of two rivers. (12th) No notable difference observed. (13th) Network of highways. (14th) Lazarettos, cordons, and disinfectants. (15th) Yes; by the working classes. (16th) In the public lavatories by the working classes. (17th) 38 days—ascend, 15; apogee, 8; descent, 15. (18th) During the epidemic the weather was dry and clear. (19th) Tendency to gastric intestinal disturbances. (20th) 910 attacks—372 males, 538 females. (21st) 333 deaths—147 males, 186 females. (22d) No statistics. (23d) In the center of the town, in the prison and eleemosynary institutions adjoining, there were no attacks, and in the infantry quarters, situated in an isolated locality beyond the town, there were some attacks, but no deaths. (24th) See the medical reports.

*Benajama*, 2,167 inhabitants.—(1st answer.) From the 27th of July to the 8th of September. (2d) From infected places by the same individual. (3d) Generally good. (4th) There is none; filth into the courts; public cleaning absent. (5th) Well; of medium quality. (6th) Probably; yes; through filtrations into the well. (7th) Calcareous; no marshes nor fevers. (8th) At 1 kilometer. (9th) There is none. (10th) This time less. (11th) Situated at 1 kilometer from the river Vinalapó; dry the greater part of the year on account of the water being withdrawn for irrigation. (12th) The portion near the river; 40 per cent. more attacked, and the attacks were less severe in the upper part. (13th) Neighboring roads. (14th) Before the epidemic, cordons and lazarettos; after, disinfectants in the houses attacked, as also in the streets. (15th) Abuse of fruits and vegetables, but during the epidemic there was abstention. (16th) In public lavatories and in the upper canal at its exit from the village. (17th) 43 days—ascend, 15; apogee, 10; descent, 18. (18th) No. (19th) Yes. (20th) 88 attacks—37 males, 51 females. (21st)

38 deaths—11 males, 27 females. (22d) Lower 67, upper 21; to the north 28, to the south 60. (23d) There are none. (24th) The first attacked remained seven days in the lazaretto of Alicante and two in this.

*Biar*, 3,103 *inhabitants*.—(1st answer.) From the 31st of July to the 31st of August. (2d) Suspected that it was imported by goods from Alcoy, surreptitiously introduced. (3d) First good; second good. (4th) There is none; cleaning by the inhabitants and the municipality. (5th) Springs and fountains; good; some magnesia. (6th) No. (7th) Granite and sand; no marshes nor fevers. (8th) At 1,600 meters. (9th) All terra-cotta. (10th) In that of 1855, the only epidemic experienced before, there were 15 attacks. (11th) Upon tableland of 300 meters elevation; there is a stream. (12th) Equally. (13th) Railways and highways. (14th) All. (15th) No. (16th) In the public lavatories; ordinarily in the houses. (17th) 32 days—ascend, 6; apogee, 4; descent, 22. (18th) No. (19th) No. (20th) 156 attacks—56 males, 100 females. (21st) 51 deaths—26 males, 25 females. (22d) Equally. (23d) There are none.

*Relleu*, 2,729 *inhabitants*.—(1st answer.) From the 9th of August to the 16th of September. (2d) By persons. (3d) First good; second bad. (4th) There is none; in three central streets there are aqueducts; the inhabitants clean. (5th) From a spring, into which a stream from another spring enters; good; also rain water collected in cisterns. (6th) It is possible by having washed the clothing of the sick in the stream of the village up the stream. (7th) Clay; there is a marsh, and fevers are frequent. (10th) The former were greater. (11th) A half a kilometer from a stream; three little brooks are confluent. (12th) Equally. (13th) Narrow, bad roads. (14th) Cordons, disinfectants, diligence, and cleanliness. (15th) Yes. (16th) In the public lavatories and in the stream. (17th) 38 days—ascend, 12; apogee, 10; descent, 16. (18th) Not with a storm, but with dense clouds and moisture in the atmosphere. (19th) Yes. (20th) 246 attacks—113 males, 133 females. (21st) 95 deaths—62 males, 33 females. (22d) Not observed. (23d) There are none.

*Torremanzana*, 1,598 *inhabitants*.—(1st answer.) From the 14th to the 28th of August. (2d) Imported. (3d) Both bad. (4th) There is none; inhabitants clean. (5th) Good spring, containing magnesia. (7th) Clay; no marshes nor fevers. (8th) About a thousand meters. (9th) Of brick. (10th) This time less. (12th) Elevated part most infected. (13th) Highways. (14th) Before the epidemic, cordons and lazarettos; after, disinfectants. (15th) Abuse of vegetables. (16th) In the public lavatories. (17th) 14 days—ascend, 6; apogee, 3; descent 5. (18th) Coincided with much cloudiness. (19th) No. (20th) 24 attacks—8 males, 16 females. (21st) 23 deaths. (22d) All in the lower. (23d) No physician.

*Monóvar*, 8,615 *inhabitants*.—(1st answer.) From the 15th to the 31st of August. (2d) A person came from Valencia; after 7 days of observation, he went to the fields, and left his clothing with one of the inhabitants to wash, after they were disinfected. The washerwoman was the first case. (3d) First good; second bad. (4th) There is none; sewage accumulates in the courts or squares for manure; cleaning in the charge of the inhabitants; only during the epidemic, the board of health required it to be removed 1,500 meters outside the town. (5th) Excellent springs. (6th) No. (7th) Calcareous; no marshes; fevers in the autumn. (8th) At 100 meters. (9th) Of stone; in bad condition. (10th) No epidemic before. (11th) Between two ranges of hills to the north and the south, and at 3 kilometers from the river Vinalapó. (12th) The nearest suffered most, and another on the top of the hill. (13th) Railways and roads. (14th) Before the epidemic, cordons and lazarettos; afterwards, disinfectants. (15th) Generally much abused; but during the epidemic the sale of all fruit was prohibited. (16th) Outside of the houses, and in the public lavatories. During the epidemic the introduction of dirty robes into the city was prohibited, and those of cholera patients were washed separately. (17th) 16 days. (18th) No. (19th) Yes. (20th) 68 attacks—23 males, 35 females. (21st) 23 deaths—8 males, 15 females. (22d) Generally in the lower. (24th) The epidemic ceased owing to the hygiene measures and to disinfection of the clothing of the cholera patients and of the houses.

*Santa Pola*, 3,219 *inhabitants*.—(1st answer.) From the 23d of July to the 28th of August. (2d) By persons. (3d) First good; second bad. (4th) There is none; the municipality is charged with the cleaning. (5th) Rain-water collected in cisterns. (6th) No. (7th) Sand and



clay; there are marshes; there are always fevers. (8th) At 285 meters. (9th) There is none. (10th) A former lighter. (11th) Upon the sea-shore. (12th) The higher part. (13th) By land and sea. (14th) Lazarettos and disinfectants. (15th) Yes. (16th) In public lavatories. (17th) 37 days—ascend, 15; apogee, 17; descent, 5. (18th) No. (19th) Yes. (20th) 128 attacks—46 males, 82 females. (21st) 61 deaths—22 males, 39 females. (22d) The majority to the south. (23d) There are none.

#### PROVINCE OF MURCIA.

*Bullas*, 6,326 inhabitants.—(1st answer.) From July 4th to September 6th. (2d) By persons. (3d) First ordinary; second bad. (4th) There is none; municipality cleans. (5th) Spring; pleasant and good. (6th) No. (7th) Clay; there are no marshes; fevers in autumn. (8th) At 900 meters. (9th) A part of the stream captured at source; brought by vessels. (10th) Equally. (11th) At 4 kilometers from the river; surrounded on the east by irrigation canal with a considerable current. (12th) Less near the river. (13th) Highways; neighboring roads. (14th) Cordons. (15th) No. (16th) In river and in the streams; each inhabitant for himself. (17th) 62 days. (18th) Increased after fogs. (19th) Yes. (20th) 406 attacks—229 males, 177 females. (21st) 148 deaths—73 males, 75 females. (22d) All in the lower; generally to the north. (24th) Usually the attacked lived in damp localities, low and badly ventilated; in those affected with chronic diseases.

*Archena*, 3,067 inhabitants.—(1st answer.) From June 4th to July 27th. (2d) By water and by springs from infected places. (3d) Both ordinary. (4th) There is none; in special places and in the courts for manure; cleaning by the municipality. (5th) Of the river Segura; by means of canals; pleasant and containing lime. (6th) The majority use river water. (7th) Clay and lime; few and small marshes; fever in autumn. (8th) 1 kilometer. (9th) An open canal. (10th) Less than the former. (11th) Half kilometer from the river Segura. (12th) In the part next the river. (13th) Railroads, highways, and neighboring roads. (14th) Both at the beginning and afterwards disinfectants. (15th) Very frequently; mostly figs and vegetables. (16th) In the streams which emptied into the river and in the river outside of the houses. (17th) 54 days. (18th) Yes; with rains. (19th) Yes. (20th) 212 attacks—112 males, 100 females. (21st) 93 deaths—43 males, 50 females. (22d) All in the lower and mostly to the north. (23d) Three attacks in the prison. (24th) Poor class most affected.

*Abaran*, 3,379 inhabitants.—(1st answer.) From June 5th to September 6th. (2d) By a woman coming from an infected place; she died. (3d) First good; second bad. (4th) There is none; inhabitants clean. (5th) From the river; pleasant; prohibited the invasion; then used fountain water. (6th) No. (7th) Plain sloping to the north; the upper strata clay with limestone beneath; intermittent fevers frequent, especially in autumn. (8th) The rate within the village; the new at 1 kilometer. (9th) There is none. (10th) Equally. (11th) Upon a hill to the left of the river 120 meters distant. (12th) 30 per cent. (13th) Highways. (14th) All. (15th) No. (16th) In ponds and in the river, and in fountain; outside of the houses once a month. (17th) 94 days—ascend, 8; apogee, 17; descent, 72. (18th) No. (20th) 87 attacks—41 males, 46 females. (21st) 40 deaths—17 males, 23 females. (22d) All in the lower; 46 to the north, 26 to the south. (24th) Greatest mortality among the weak.

*Totana*.—(1st answer.) From July 11th to October 13th. (2d) By sick person from Murcia, Lorca, and Cartagena. (3d) Both good. (4th) There is none; excrementary moved by the inhabitants who are beyond the village; municipality causes cleaning of the streets every day. (5th) Springs upon the mountain España; excellent and pleasant. (6th) No. (7th) Clay; limestone; no marshes; ordinarily intermittent fever not frequent; some in autumn. (8th) At 1 kilometer to the north. (9th) Of brick. (10th) This village has always been attacked and suffered severely; this time there was no cordon. (11th) No streams or rivers near the village; 6 kilometers distant from the Guadalentia. (13th) Railways and roads. (14th) Rigorous sanitary inspection; isolation; disinfection of the infested houses. (15th) All kinds of fruit and vegetables used, there being abundance of both. (16th) In the lavatories and in the running water. (17th) 115 days. (19th) Yes. (20th) 8 attacks—4 males, 4 females. (21st) 7 deaths—3 males, 4 females. (22d) All in lower. (23d) No attack in the post of the civil guard. (24th) Physicians believe that by isolation and hygiene contagion of cholera is to be avoided.

*Caravaca*, 15,017 inhabitants.—(1st answer.) From June 20th to September 6th. (2d) First case on June 9 in a laborer; came from Archena; no new case until some days after. (3d) First good; second bad. (4th) There is none; deposits in the court-yards; municipality cleans. (5th) Spring; pleasant, contains carbonates of lime and magnesia. (6th) Believed to have drunk irrigation water. (7th) Clay and limestone; there are marshes and fevers in autumn. (8th) 300 meters. (9th) Iron. (10th) More in the former. (11th) Some distance from a river. (12th) 25 per cent. (13th) Highways and neighboring roads. (14th) All. (15th) Yes; abuse of fruits. (16th) In public lavatories; generally outside of houses. (17th) 78 days—ascend, 32; apogee, 19; descent, 27. (18th) No. (19th) Yes. (20th) 600 attacks—296 males, 304 females. (21st) 244 deaths—114 males, 130 females. (22d) Majority in the lower, though almost all to the south; 93 post of the civil guard; there were 3 attacks, and in the prison 4.

*Albudeite*.—(1st answer.) From the 20th of June to the 30th of September. (2d) Unknown. (3d) Both bad. (4th) There is none; public cleaning by the inhabitants. (5th) River and fountain; pleasant, containing lime and magnesia. (7th) Granite and clay; no marshes, but fevers frequent in August and September. (8th) At 200 meters; a new is being sought at 1,000 meters. (9th) By canals. (10th) Equally. (11th) Upon the river Mula, and a saline spring. (12th) Several men near the saline spring. (13th) By land. (14th) Cordons and disinfectants. (15th) Abuse of fruits. (16th) In the river. (17th) 100 days. (18th) Strong south winds prevail during the epidemic. (19th) Yes. (20th) 117 attack—53 males, 64 females. (21st) 43 deaths—17 males, 26 females. (22d) All in the lower, and majority to the south. (23d) There are none.

*Alhama*.—(1st answer.) From the 23d of June to the 24th of August. (2d) Unknown. (3d) First, good; second, bad. (4th) There is none; deposits in the court-yards; cleaning by the inhabitants. (5th) Springs; pleasant, containing magnesia. (6th) No. (7th) Clay and limestone; no marshes; fevers generally in July and August. (8th) 116 meters. (9th) The aqueducts are of limestone. (10th) This time less. (11th) No river nor brook in the neighborhood of the village. (13th) Railway and roads. (14th) Cordons; lavatories and disinfectants. (15th) Abundance of fruits and vegetables. (16th) In the public lavatories; washerwomen in charge; it is done also in the houses. (17th) 62 days—ascend, 12; apogee, 16; descent, 34. (18th) With cloudy and warm weather the attacks of mortality increased. (19th) 247 attacks—121 males, 126 females. (21st) 88 deaths—39 males, 49 females. (22d) All in the lower; there are scarcely any; equally to the north and south.

*Murcia*, 93,892 inhabitants.—(1st answer.) From June 5th to September 29th. (2d) By troops proceeding from Valencia arriving at Archena; from there brought to Murcia. (3d) In the military hospital the first cases occurred; this was the sole focus from which the epidemic spread. (4th) Small extent of sewerage; in bad condition; emptying into the river near the center of the town; a part of the sewerage flows into a canal which runs close to many houses. (5th) River water, which is collected in large earthen jars, and it contains organic matter in suspension; the jars of the poor are dirtier; there are also wells for domestic purposes. (6th) Both the river and the well water are suspected. (7th) Subsoil, sand, and clay; the soil alluvium, wash down from the mountains by the rains; very damp. (8th) Cemeteries are some kilometers distant from the city. (9th) There is none. (10th) Experienced epidemics in 1834, 1854, 1855, 1859, and 1865. (11th) Upon the banks of the river Segura. (12th) Yes; particularly the houses of the orchards near the river, and in the Sangua, San Antonio. (13th) Highways and railroads. (14th) Isolation of the attacked and their families; burning of the clothing used by them and disinfection of their dwellings. (15th) Yes. (16th) In the river and in the canals. (17th) 116 days—ascend, 25; apogee, 15; descent, 76. (18th) Yes. (19th) From the middle of May diarrhoeas of a common choleraic character were frequent. (20th) 5,005 attacks. (21st) 2,102 deaths. (24th) There was no doubt that miserable hygienic conditions was the cause of the great mortality.

*Cartagena*, 78,535 inhabitants.—(1st answer.) From June 11th to September 30th. (2d) Imported by a prostitute coming from Muria, who propagated it to the soldiers and washerwomen, who in turn spread the disease through the whole city. (3d) Both very bad. (4th) There is none; public cleaning done by the municipality. (5th) Spring and wells. (6th) No. (7th) Subsoil, clay; soil, alluvium; malarial fevers frequent. (8th) Outside of town. (9th) There



is none. (10th) Suffered also from former epidemics. (11th) On the sea-shore. (12th) Yes; but near the sea suffered most. (13th) Railways; by land and sea. (14th) At the beginning; cordons and lazarettos; afterwards only disinfectants and hygienic measures. (15th) Yes. (16th) Washing outside of houses in general. (17th) 110 days—ascend, 34; apogee, 18; descent, 58. (18th) The apogee coincided with the first rains; after the latter continued for a time a rapid descent occurred. (20th) 2,460 attacks. (21st) 1,200 deaths. (24th) Mortality of attacks 29 per 100.

*Beniel*, 2,400 *inhabitants*.—(1st answer.) From August 19th to October 12th. (2d) By a person from Murcia, who had communicated the disease to various persons of her family. (3d) Both bad; in the center of the town there are collections of excrement. (4th) There is none; excrement emptied into the court-yards; dirty water into the street even in the epidemic. (5th) Good springs and well-water for domestic uses. (6th) Supposed due to use of reservoir water. (7th) Soil is calcareous; subsoil contains lead-bearing veins; situated upon a declivity of a spur of the San Cristobal mountain. (9th) Aqueducts of loose masonry. (10th) Suffered in 1855; escaped in 1865. (11th) Near a torrent. (12th) Suffered most in the ward near the torrent. (13th) By land. (14th) Fumigations only. (17th) 64 days—ascend, 10; apogee, 10; descent, 44. (20th) 260 attacks. (21st) 90 deaths.

*Mazarron*, 11,000 *inhabitants*.—(1st answer.) From June 9th to September 15th. (2d) Unknown. (3d) Both bad. (4th) There is none; cleaning badly performed. (5th) From the river Segura; many villages, including Murcia, situated upon this stream were attacked; they were situated above. (6th) The river Segura. (7th) Soil very damp; clay; frequent and pernicious malarial fevers. (9th) There is none. (10th) Upon the river Segura. (12th) By land. (13th) Disinfectants; all being ineffectual. (16th) Lavatories outside of houses. (17th) 96 days. (20th) 80 attacks. (21st) 41 deaths. (23d) The family of one of the attacked threw the dejection into an irrigation reservoir. (24th) The lazaretto near this was infected, there being 5 attacks and 2 deaths; this focus of disease ceased upon the emptying of the contaminated water.

*Blanca*, 4,100 *inhabitants*.—(1st answer.) From June 9th to August 20th. (2d) Supposed to be imported from Murcia, in spite of a rigorous cordon. (3d) Both bad. (4th) There is none; everything empties into an irrigation canal. (5th) From the river Segura, which is also used for irrigation. (6th) The river Segura. (7th) Moist clay soil and much fever of all kinds. (9th) There is none. (11th) Upon the river Segura. (12th) The dirtiest and poorest quarters suffered most. (13th) By land. (14th) Cordons; isolation, disinfectants; all without effect. (20th) 227 attacks—105 males, 122 females.

#### PROVINCE OF CASTELLON DE LA PLANA.

*Almazora*, 5,827 *inhabitants*.—(1st answer.) From June 5th to August 23d. (2d) By persons from infected places. (3d) First good; second bad. (4th) There is none; excrement deposited in court-yards for manure; cleaning by the inhabitants. (5th) From the river Mijares and from some cisterns and wells containing hard lime water. (6th) River Mijares, where the clothing of the infected villages was washed up-stream. (7th) Quaternary; conglomerate; alternating with strata of gravel and clay; no fevers; marshes. (8th) At the side of the village. (9th) There is none. (10th) Suffered some in the former. (11th) To the north of the river Mijares. (12th) Twenty per cent. in the lower part; the majority proprietors. (13th) Railways and roads. (14th) Cordons, lazarettos; disinfectants and isolation. (15th) Yes; canteloupes, watermelons, peppers, tomatoes, etc. (16th) In a public lavatory; in a canal and pools. (17th) 78 days—ascend, 35; apogee, 23; descent, 25. (18th) Indistinctly. (19th) Yes. (20th) 770 attacks—321 males, 449 females. (21st) 224 deaths—84 males, 140 females. (22d) Equally. (24th) The cemetery and the washing of the clothes in the canals were the cause of infection.

*Sot de Ferrer*, 844 *inhabitants*.—(1st answer.) From June 7th to August 2d. (2d) By persons from infected places who died. (3d) First good; second bad. (4th) There is none; excrement deposited in the court-yards for manure; cleaning by the inhabitants. (5th) From the river

and spring; good and pleasant. (6th) It is suspected that in villages along the upper part of the river there was washing of clothes of cholera patients; a part of the village used river water. (7th) Upon a spur of a small mountain of the Espadan; clay, limestone, rocks, and sandy clay; there are no marshes; few fevers in autumn. (8th) There are two cemeteries, both near the village. (9th) There is none. (10th) More this time. (11th) The river Palencia flows at the foot of the mountain upon which the village is situated. (12th) The lower part 18 per cent. more affected. (13th) Highways. (14th) Cordons, lazarettos, disinfectants. (15th) Abuse of fruits and vegetables. (16th) In the canals, with abundance of water. (17th) 57 days—ascend, 10; apogee, 24; descent, 20. (18th) Greatest number of attacks coincided with the second, third, and fourth days following rains. (19th) Yes. (20th) 32 attacks—17 males, 15 females. (21st) 12 deaths—6 males, 6 females. (22d) Majority in the lower. (23d) In the post of the civil guard two attacks followed by death. (24th) The mortality was  $37\frac{1}{2}$  per cent. of the attacked.

*Burriana*, 10,058 *inhabitants*.—(1st answer.) From June 9th to August 19th. (2d) By effects from Valencia. (3d) First good; second bad. (4th) There is none; excrement deposited in the court-yards for manure; cleaning by the inhabitants. (5th) From the river Mijares, conducted by a canal, and from wells; good and pleasant. (6th) No. (7th) Clay and damp; no marshes, but fevers in spring and autumn. (8th) At 1 kilometer. (9th) There is none. (10th) More this time. (11th) At the side of a dry river. (12th) Equally. (13th) Railways; by land and sea. (14th) All three. (15th) Yes. (16th) In the canals and in the houses beside. (17th) 70 days—ascend, 11; apogee, 20; descent, 39. (18th) Yes; during the development. (19th) Yes. (20th) 603 attacks—253 males, 350 females. (21st) 250 deaths—125 males, 125 females. (22d) 180 to the south; 70 to the north.

*Alcalá de Chisvert*, 6,129 *inhabitants*.—(1st answer.) From June 15th to August 1st. (2d) By persons from infected places. (3d) First good; second bad. (4th) There is none; excrement deposited in the court-yards for manure; cleaning by the inhabitants. (5th) Rain-water, which filters through the soil; it is collected in tanks; as also some wells, with water of the same origin; good; agreeable. (6th) Yes. (7th) Clay; no marshes nor malarial fevers. (8th) At half kilometer. (9th) There is none. (10th) More this time. (11th) At 6 kilometers distance. (13th) By land. (14th) All three. (15th) Yes. (16th) In houses and in tanks. (17th) 41 days—ascend, 14; apogee, 15; descent, 12. (18th) Yes. (19th) Yes. (20th) 2,500 attacks. (21st) 700 deaths.

*Toga*, 409 *inhabitants*.—(1st answer.) From June 25th to July 3d. (2d) By effects from infected places. (3d) Very bad. (4th) There is none; excrement deposited in the court-yards for manure; cleaning by the inhabitants. (5th) Spring and river water; the first contains magnesia. (6th) Yes. (7th) Limestone; no marshes nor malarial fevers. (8th) At 250 meters. (9th) There is none. (10th) Equally. (11th) Near the river Mijares. (12th) The part near the river suffered most. (13th) By land. (14th) Lazarettos, cordons, and disinfectants. (15th) Abuse of fruits. (16th) In public lavatories; river water. (17th) 9 days—ascend, 3; apogee, 2; descent, 4. (18th) No. (19th) Yes. (20th) 11 attacks—5 males, 6 females. (21st) 7 deaths—2 males, 5 females. (22d) All in the first and to the north.

*Figueroles*, 830 *inhabitants*.—(1st answer.) From June 25th to July 26th. (2d) It is believed by persons in communication with others from infected places. (3d) Both good. (4th) There is none; the excrement deposited in court-yards for manure; cleaning by the inhabitants. (5th) From the river in winter and springs in summer; from filtrations from the same river; good; hard, containing lime. (6th) No. (7th) At the foot of a mountain; no marshes nor malarial fevers. (8th) At 1 kilometer. (9th) There is none. (10th) Little difference. (11th) Upon the river Lucena at 100 meters distant. (12th) The lower part suffered most; the streets next the river twice as much as the other. (13th) Highways; neighboring roads. (14th) Cordons, lazarettos, and disinfectants. (15th) No. (16th) In the river during the epidemic; after being disinfected in localities designated by the authorities. (17th) 31 days—ascend, 14; apogee, 8; descent, 9. (18th) No. (19th) Yes. (20th) 19 attacks—14 males, 5 females. (21st) 12 deaths—9 males, 3 females. (22d) All in lower, there being no upper.



*Geldo*, 785 inhabitants.—(1st answer.) From July 11th to July 26th. (2d) By communication with persons coming from infected points. (3d) Both good. (4th) The same as in other villages, only that the inhabitants make use of the canals to conduct the sewerage to the fields. (5th) Springs and river water, first containing magnesia. (6th) No. (7th) Granite; no marshes nor malarial fever. (8th) 100 meters. (9th) Brick. (10th) More this time. (11th) Upon the river Palamba. (12th) Most in the center. (13th) By land. (14th) Cordons and lazarettos. (15th) Salads. (16th) In public lavatories. (18th) No. (19th) Yes. (20th) 9 attacks—5 males, 4 females. (21st) 2 deaths—2 males. (22d) All in the upper and to the south.

*Castellfort*, 1,641 inhabitants.—(1st answer.) From July 16th to August 21st. (2) By persons. (3d) Both bad. (4th) There is none; excrements deposited in court-yard for manure; inhabitants clean. (5th) From the river in winter and from springs in summer; good; hard; contains lime; springs are pleasant and hard. (6th) No. (7th) Upon a rock; no marshes nor malarial fevers. (8th) At a quarter of an hour. (9th) There is none. (10th) Less this time. (11th) There are pools when it rains and snows. (13th) Neighboring roads. (14th) Cordons, lazarettos, and disinfectants. (15th) No. (16th) In public lavatories and brooks. (17th) 36 days—ascend, 9; apogee, 9; descent, 18. (18th) It rained one day before the appearance of the epidemic. (19th) Yes. (20th) 294 attacks—125 males, 169 females. (21st) 132 deaths—61 males, 71 females. (22d) Unknown.

*Benicarló*, 7,922 inhabitants.—(1st answer.) From July 7th to August 28th. (2d) Unknown. (3d) Good. (4th) There is none; excrement deposited in the court-yards for manure; cleaning by the inhabitants. (5th) Good; wells containing chloride of lime. (6th) No. (7th) Sandy clay and granite; no marshes nor malarial fevers. (8th) One and one-half kilometers. (9th) There is none. (10th) 54 more this time. (11th) Upon a dry river. (12th) Equally. (13th) Railways and highways and by sea. (14th) All three. (15th) Yes; figs, salads, grapes, etc. (16th) In lavatories at the river side, half kilometer distant. (17th) 52 days—ascend, 12; apogee, 18; descent, 22. (18th) No. (19th) No. (20th) 408 attacks—168 males, 240 females. (21st) 171 deaths—71 males, 100 females.

*Almedijaz*, 910 inhabitants.—(1st answer.) From July 18th to August 25th. (2d) It is thought by persons from infected places. (3d) Some ordinary; others bad. (4th) There is none; excrements deposited in court-yards for manure; cleaning by the inhabitants. (5th) Springs; good, hard, containing magnesia and lime. (6th) No. (7th) Sandy clay; no marshes or malarial fevers. (8th) At 25 meters. (9th) There is none. (10th) More this time. (11th) In a ravine between mountains. (12th) Equally. (13th) Highways. (14th) Cordons, lazarettos, and disinfectants. (15th) Yes; fruits and vegetables. (16th) In public lavatories and streams. (17th) 37 days—ascend, 5; apogee, 14; descent, 18. (18th) Unknown. (19th) Yes. (20th) 25 attacks—10 males, 15 females. (21st) 7 deaths—3 males, 4 females. (22d) All in the entresol; to the north, 10; to the south, 15.

*Candia*, 1,782 inhabitants.—(1st answer.) From July 26th to August 27th. (2d) By persons. (3d) The first good. (4th) Same as the former, only that cleaning is done by the municipality. (5th) Spring; good and pleasant, containing sulphates and carbonates. (6th) No. (7th) Clay and limestone; no marshes nor malarial fevers. (8th) At 220 meters. (9th) Of brick. (10th) More this time. (11th) There is none. (13th) By land. (14th) Cordons, lazarettos, and disinfectants. (15th) Yes; salads and fruits. (16th) In public lavatories. (17th) 31 days—ascend, 14; apogee, 8; descent, 9. (18th) With fogs during which the epidemic increased. (19th) Yes. (20th) 108 attacks—47 males, 61 females. (21st) 34 deaths—15 males, 19 females. (22d) All in the upper; 40 to the north, 68 to the south.

*La Mata*, 782 inhabitants.—(1st answer.) From August 1st to September 24th. (2d) By persons from infected places. (3d) Both ordinary. (4th) Everything wanting. (5th) Springs and fountains; good. (6th) No. (7th) Clay, limestone; no marshes nor fevers. (8th) At 600 meters. (9th) There is none. (10th) This time more. (11th) Confluence of two rivers, 300 meters distant. (12th) Equally. (13th) Highways. (14th) Cordons and lazarettos; disinfection with carbolic acid. (15th) No. (16th) In the rivers. (18th) With hail. (20th) 90 attacks—44 males, 46 females. (21st) 21 deaths—9 males, 12 females. (22d) Without distinction.

*San Jorge*, 1,612 inhabitants.—(1st answer.) From August 7th to September 11th. (2d) Unknown. (3d) Some good; others ordinary. (4th) There is none; cleaning by the inhabitants. (5th) Rain-water, collected in cisterns; well-water and reservoirs. (6th) No. (7th) Clay, sand; there is malarial fever in summer. (8th) At 1,500 meters. (9th) Four cisterns; zinc pipes and iron. (10th) Much less this time. (11th) Upon a small hill. (13th) By land. (14th) Cordons, lazarettos, and much disinfection. (15th) Yes; cantaloupes, watermelons, and grapes. (16th) In private basins and in pools. (17th) 35 days—ascend, 23; apogee, 8; descent, 4. (18th) Yes, 4 or 5 days. (19th) Yes. (20th) 368 attacks—154 males, 214 females. (21st) 105 deaths—46 males, 59 females. (22d) 251 upper, 117 lower; 213 to the south, 155 to the north. (23d) In the post of the civil guard 5 persons more than in the civil population.

*Villafamés*, 4,918 inhabitants.—(1st answer.) From June 11th to August 28th. (2d) By persons. (3d) First good; second very bad. (4th) Same as the former, only that the inhabitants clean. (5th) springs; good, agreeable, containing magnesia and iron. (6th) No. (17th) Upon rocks; there is no marsh; there are no fevers. (8th) At 800 meters. (9th) There is none. (10th) In 1834 only a few cases; in 1855 there were many more. (11th) No. (13th) Neighboring roads. (14th) All three. (15th) Yes; grapes and summer fruits. (16th) In public lavatories. (17th) Yes. (18th) No. (19th) Yes. (20th) 26 attacks—8 males, 18 females. (21st) 7 deaths—1 male, 6 females. (22d) All in the lower.

*Forcal*, 1,953 inhabitants.—(1st answer.) From August 12th to September 6th. (2d) By a harvester. (3d) Both very bad. (4th) Same as the former. (5th) Spring; pleasant and agreeable. (6th) No. (7th) Compact limestone; no marshes nor fevers. (8th) At 500 meters. (9th) There is none. (10th) More this time. (11th) At the confluence of three rivers. (12th) Equally. (13th) By land. (14th) Disinfectants. (15th) No. (16th) in rivers; outside of the houses. (17th) 24 days—ascend, 10; apogee, 8; descent, 6. (18th) Unknown. (19th) Yes. (20th) 124 attacks—39 males, 85 females. (21st) 65 deaths—26 males, 39 females.

#### PROVINCE OF TERUEL.

*Calamocha*, 1,752 inhabitants.—(1st answer.) From July 4th to September 2d. (2d) By both modes. (3d) Good. (4th) There is none; inhabitants clean. (5th) Good; from river. (6th) No. (7th) Clay and limestone; there are no marshes nor frequent fevers. (8th) At 600 meters. (9th) There is none. (10th) Formerly more benign. (11th) Yes, upon the Giloca. (12th) Little difference. (13th) Highways. (14th) Good hygiene. (15th) General abuse of fruits and vegetables. (16th) In public lavatories and in the river. (17th) 58 days—ascend, 30; apogee, 15; descent, 13. (18th) No coincidence with storms and rains. (19th) Yes, preceded by tendency to diarrhoea. (20th) 362 attacks—138 males, 224 females. (21st) 65 deaths. (22d) In the lower; to the south, 200 attacks; to the north, 162. (23d) One attack in the post of the civil guard. (24th) The greatest number of attacks was in the women and in the unhealthy.

*Teruel*, 9,510 inhabitants.—(1st answer.) From July 5th to September 3d. (2d) Imported by a wagoner from Valencia, who died. (3d) Both very bad. (4th) Little and bad; majority sickly; the excrement into court-yards; cleaning by the municipality. (5th) The majority use water of the river Guadalaviar, and a minority from a fountain of bad quality. (6th) Although imported, the epidemic was spread by use of river water infected in its passage by other infected villages. (7th) Alluvial soil; subsoil clay; impermeable but inclined, for it is on the side of a hill. (8th) At 400 meters; on the top of an elevation higher than the city. (9th) The majority in brick pipes. (10th) Equally. (11th) Upon the Turia formed by the confluence of the Guadalaviar and the Alfamra. (12th) Was considerably more attacked than the others, but it was difficult to calculate the proportions. (13th) Highways; it is in frequent personal and commercial communication with Valencia, a point from whence the disease was imported. (14th) All. (15th) Little abuse during the epidemic. (16th) Generally in the river; no public lavatories. (17th) 60 days—ascend, 28; apogee, 23; descent, 9. (18th) No. (19th) Although the epidemic was not preceded by either, the latter coincided with the first days of the epidemic. (20th) 1,138 attacks—515 males, 623 females. (21st) 507 deaths—249



males, 258 females. (22d) Lower stories are not inhabited. (23d) No case occurred in the infantry garrison; in the public prison, among 40 persons, there were 3 attacks and 1 death. (24th) Bad hygienic conditions; ignorance and fear were potent causes of the development of the disease.

*Luco de Giloca, 770 inhabitants.*—(1st answer.) From July 6th to August 17th. (2d) Unknown. (3d) Bad. (4th) There is none; cleaning by the inhabitants. (5th) From the river. (6th) Yes. (7th) Sandy; no marshes nor malarial fevers. (8th) Near. (9th) There is none. (10th) Equally. (11th) At 200 meters from a river. (12th) In the same proportion. (13th) Highways. (14th) Disinfectants. (15th) Yes, especially cherries, etc. (16th) Generally in the river. (17th) 41 days—ascend, 15; apogee, 10; descent, 16. (18th) After a storm. (19th) Yes. (20th) 76 attacks—30 males, 46 females. (21st) 39 deaths—15 males, 24 females. (22d) Unknown.

*Burbaguena, 1,253 inhabitants.*—(1st answer.) From July 9th to August 17th. (2d) Unknown. (3d) Very bad. (4th) Everything wanting. (5th) Natural springs in calcareous soil, and from river Logica. (6th) From the river. (7th) Granite and limestone; no marshes nor fevers. (8th) Within the village. (9th) Iron. (10th) In 1865 more. (11th) On the banks of the Giloca. (12th) The most elevated suffered most. (13th) Highway and neighboring roads. (14th) Disinfectants: carbolic acid; chloride of lime. (15th) Considerable abuse of fruits and vegetables. (16th) In the river. (17th) 39 days—ascend, 20; apogee, 6; descent, 13. (18th) With atmospheric changes. (19th) Yes. (20th) 102 attacks—51 males, 51 females. (21st) 31 deaths—12 males, 19 females. (22d) All in the lower; majority to the south.

*Peralejos, 345 inhabitants.*—(1st answer.) From July 9th to August 17th. (2d) Imported by persons. (3d) Good. (4th) There is none; excrement removed to a certain place for its collection; cleaning by the inhabitants. (5th) From the river. (6th) No. (7th) Clay, subsoil rocky; no marshes nor frequent fevers. (8th) At 1 kilometer. (9th) From the river Alfambra. (10th) The former less. (11th) Upon the banks of the river Alfambra. (12th) Equally. (13th) By land. (14th) Hygiene; disinfectants; fumigations. (15th) Ordinarily. (16th) Washing in the houses. (17th) 39 days—ascend, 10; apogee, 10; descent, 19. (18th) No. (19th) No. (20th) 36 attacks—14 males, 22 females. (21st) 14 deaths—5 males, 9 females. (22d) Generally in the lower; 31 in the upper; equally as respect to winds. (23d) There are none. (24th) No.

*Valbona, 805 inhabitants.*—(1st answer.) From the 11th of July to the 4th of September. (2d) Unknown. (3d) First ordinary; second bad. (4th) There is none; the excrement deposited in the courts; cleaning by the municipality. (5th) From the river Torniche; contains lime. (6th) No. (7th) Sandy; no marshes nor fevers. (8th) At 1 kilometer. (9th) There is none. (10th) Equally. (11th) To the left of the river Torniche. (12th) More in the higher part. (13th) By land. (14th) Cordons, lazarettos, and disinfectants. (15th) No. (16th) In the river, outside houses. (17th) 54 days—ascend, 33; apogee, 12; descent, 7. (18th) No. (19th) No. (20th) 133 attacks—46 males, 87 females. (21st) 42 deaths—15 males, 27 females. (22d) Houses only one story.

*Castejón, 483 inhabitants.*—(1st answer.) From July 12th to August 28th. (2d) By persons and effects from infected places. (3d) Both very bad. (4th) Cleaning at the charge of the municipality. (5th) Proceeded from water procured from ponds and from the river Martin; it is pleasant, but of bad quality. (6th) No. (7th) Clay; limestone; there are marshes; very frequent malarial fevers. (8th) At 200 meters. (9th) There is none. (10th) Suffered less in the former epidemics. (11th) Upon the river Martin; besides the village is traversed by a stream which carries organic and putrifying matter. (12th) The part near this stream was most affected. (13th) By land. (14th) By cordons and disinfectants. (15th) Abuse of fruits and vegetables. (16th) In rivers and houses. (17th) 49 days—ascend, 23; apogee, 12; descent, 14. (18th) No. (19th) Yes. (20th) 37 attacks—16 males, 21 females. (21st) 25 deaths—8 males, 17 females. (22d) The most of the houses have only one story. (23d) There are none. (24th) Bad hygienic conditions during the epidemic.

*Crivillén*, 891 *inhabitants*.—(1st answer.) From July 13th to December 3d. (2d) Imported by a person coming from an infected place. (3d) Ordinary; nothing noteworthy. (4th) There is none; cleaning by the inhabitants. (5th) Good spring water, containing lime and magnesia. (6th) No. (7th) Sandy and clay; no marshes nor frequent intermittent fevers. (8th) At 600 meters. (9th) Of brick. (10th) This time less. (11th) Upon a river. (12th) Equally. (13th) By land. (14th) Both. (15th) Yes; vegetables. (16th) Washing in brook. (17th) 67 days—ascend, 53; apogee, 8; descent, 6. (18th) No. (19th) Yes. (20th) 142 attacks—45 males, 97 females. (21st) 36 deaths—8 males, 28 females. (22d) All in upper; indifferently to the south and north. (23d) There are none. (24th) Nothing.

*Campos*, 264 *inhabitants*.—(1st answer.) From July 16th to August 30th. (2d) Imported by persons. (3d) Both bad. (4th) There is none; cleaning by the inhabitants. (5th) Good spring water. (6th) No. (7th) Granite; neither marshes nor intermittent fever. (8th) Near the village. (9th) There is none. (10th) In 1855 less. (11th) At the foot of a hill. (12th) In the lower part in the proportion of 4 to 100. (13th) By roads. (14th) Disinfectants when the epidemic occurred. (15th) No. (16th) Washing in the houses. (17th) 45 days. (18th) Yes; there were more attacks. (19th) Yes. (20th) 41 attacks—20 males, 21 females. (21st) 10 deaths—6 males, 4 females. (22d) All lower and to the east. (23d) There are none.

*Albulate del Arzobispo*, 4,182 *inhabitants*.—(1st answer.) From the 16th of July to the 18th of August. (2d) Unknown; appeared in a sudden manner coincident with a great storm. (2d) Miserable. (4th) There is none; cleaning by the inhabitants; the excrement goes to the river. (5th) Spring and river water; majority use the river. (6th) No. (7th) Clay and limestone; no marshes; malarial fevers frequent in spring and autumn. (8th) At 1 kilometer to the east. (9th) There is none. (10th) From that of 1834 they have decreased to the present, there being four epidemics. (11th) Upon the shores of the river Martin and surrounded by canals. (12th) Equally. (13th) Very bad roads. (14th) All without exception. (15th) Much abuse; during the epidemic abstained. (16th) Washing in the river; it is a custom to keep the soiled clothing in the houses for a long time. (17th) 33 days—ascend, 12; apogee, 3; descent, 18. (18th) No; the greatest mortality occurred during the dry season; it came during a great tempest and a descent occurred after a heavy rain. (19th) No. (20th) 694 attacks—319 males, 375 females. (21st) 253 deaths—114 males, 139 females. (22d) Equally in the upper and lower. (23d) Post of civil guard very much attacked. (24th) No sort of hygiene.

*Calanda*, 3,800 *inhabitants*.—(1st answer.) From the 16th of July to the 6th of September. (2d) Imported by persons in communication with an infected village. (3d) Good. (4th) There is none; no one charged with cleaning. (5th) Good river water. (6th) No. (7th) Good; no marshes nor fevers. (8th) At 1,500 meters. (9th) Of brick. (10th) This is the worst. (11th) Near the rivers Guadalupe and Guadalupe. (12th) Began in the quarters near the river; afterwards all suffered equally. (13th) Highways and neighboring roads. (14th) Cordons and lazarettos badly located, and disinfectants badly used. (15th) Yes, but abstained during the epidemic. (16th) Customary to wash in the river, but washing is done in the houses also. (17th) 52 days—ascend, 10; apogee 6; descent, 36. (18th) Yes; slight rains coincided with the greatest development. (19th) Yes. (20th) 875 attacks—370 males, 505 females. (21st) 472 deaths—213 males, 259 females. (22d) All in the upper and in every direction. (23d) There are none.

*Fuentes Claras*, 959 *inhabitants*.—(1st answer.) From the 16th of July to the 29th of August. (2d) Unknown. (3d) Bad. (4th) There is none; excrement to special places; cleaning by the inhabitants. (5th) Spring and river water good. (6th) No. (7th) Clay and limestone; there are marshes, but no fevers. (8th) At 600 meters. (9th) There is none. (10th) In 1834 it was greater, and in 1855 and 1856 it was less. (11th) At the confluence of several rivers. (12th) 20 per cent. more in the higher parts. (13th) By land. (14th) Disinfectants. (15th) No. (16th) In river. (17th) 44 days—ascend, 12; apogee, 6; descent, 26. (18th) Yes. (19th) Yes. (20th) 62 attacks—12 males, 50 females. (21st) 16 deaths—2 males, 14 females.

*La Puebla de Híjar*, 2,510 *inhabitants*.—(1st answer.) From the 17th of July to the 19th of August. (2d) Unknown. (3d) First good; those of the houses of the first persons attacked



were inferior. (4th) There is none; the municipality orders the cleaning of the yards frequently. (5th) Ordinary; it proceeds from filtration, from irrigated fields, and from rains. (6th) No. (7th) Clay; sulphate of lime; intermittents. (8th) At 1,800 meters. (9th) There is none. (10th) Former less, so far. (11th) On irrigation canals; with scarce water. (13th) Railway. (14th) Disinfectants. (17th) 36 days. (20th) 253 attacks—137 males, 116 females. (21st) 59 deaths—33 males, 26 females.

*Ariño*, 1,288 *inhabitants*.—(1st answer.) From the 17th of July to the 30th of August. (2d) Imported by a person. (3d) Both miserable. (4th) There is none; rains do the cleaning. (5th) From the rivers Martin and Escurzo; good in winter. (6th) No. (7th) Good. (8th) Near the village. (9th) There is none. (10th) That of 1855 same as the others; those of 1864 and 1865 less. (11th) On the banks of two rivers. (12th) Equally. (13th) By land. (14th) Cordons and lazarettos until the epidemic began. (15th) Several fruits; cucumbers and tomatoes during the epidemic. (16th) In the river; no public lavatories. (17th) 44 days—ascend, 13; apogee, 6; descent, 25. (18th) Yes; in a few days cholera appeared. (19th) Yes. (20th) 296 attacks. (21st) 90 deaths—54 males, 36 females. (22d) Unknown. (23d) There are none. (24th) Bad hygienic conditions and bad food.

*Alcañiz*, 7,336 *inhabitants*.—(1st answer.) From the 17th of July to the 5th of September. (2d) Every way, for importation was frequent. (3d) All miserable. (4th) Only two in streets; the night soil is turned into the streets; cleaning by the municipality. (5th) River and fountain water, good. (6th) Unknown. (7th) Clay and limestone; there are marshes and fevers. (8th) 750 meters. (9th) There is none. (10th) This village has always been invaded; the former less intense. (11th) Upon the banks of the Guadaloque; the lower part near the river. (12th) The lower suffered three times less than the upper. (13th) By land. (14th) Cordons and lazarettos. (15th) Yes. (16th) In public lavatories, in the river, in canals, and ordinarily in the houses. (17th) 50 days—ascend, 10; apogee, 8; descent, 32. (18th) No; a storm on the evening before the day when the cholera began. (19th) No. (20th) 745 attacks—397 males, 348 females. (21st) 324 deaths—136 males, 188 females. (22d) More in the lower; more to the south than to the north. (23d) The prison was not invaded. (24th) The physicians believe the infection was conveyed by river water; also by other means.

*Pancredo*, 423 *inhabitants*.—(1st answer.) From the 17th of July to the 11th of September. (2d) Imported by a person. (3d) Good. (4th) There is none; the rains wash away the filth on account of a considerable declivity of the ground. (5th) Good river and spring water, containing lime and magnesia. (6th) No. (7th) Sand, granite, and clay; no fevers. (8th) Within the village. (9th) Of brick. (10th) During the former epidemic there were two cases. (11th) Upon rivers and brooks. (12th) Equally. (13th) Highways and railways. (14th) Cordons and disinfectants. (15th) No consumption of fruits or vegetables. (16th) In the rivers and in brooks. (17th) 54 days—ascend, 20; apogee, 16; descent, 18. (18th) Yes. (19th) Yes. (20th) 63 attacks—41 males, 22 females. (21st) 39 deaths—33 males, 6 females. (22d) In the lower 26; in the upper 37; to the north 38; to the south 26.

*Barrachina*, 673 *inhabitants*.—(1st answer.) From the 17th of July to the 6th of September. (2d) Imported by a person. (3d) Ordinary; altogether in the lower quarters, which are extremely damp. (4th) There is none. (5th) Good spring water. (6th) No. (7th) Limestone; no marshes nor fevers. (8th) 400 meters. (9th) There is none. (10th) In 1855 less invasions and more deaths than in this. (11th) Upon a small river. (12th) Equally. (13th) By land. (14th) No hygienic measures. (15th) No. (16th) In the river and in the houses. (17th) 51 days—ascend, 19; apogee, 10; descent, 22. (18th) No. (19th) No. (20th) 104 attacks—38 males, 66 females. (21st) 14 deaths—6 males, 8 females. (22d) Almost all in the upper; the same to the north as to the south. (23d) There are none.

*Samper de Calanda*, 2,673 *inhabitants*.—(1st answer.) From the 18th of July to the 27th of August. (2d) Imported by persons and effects. (3d) Good; the highest part. (4th) There is none; excrement in court-yards; the municipality clean. (5th) Rains collected in the reservoirs; also from the river Martin. (6th) Yes. (7th) Clay and limestone; no marshes; fever in autumn. (8th) At 500 meters. (9th) There is none. (10th) Mortality same as in former. (11th)

At 300 meters from the river Martin. (12th) Equally. (13th) Neighboring roads. (14th) Cordons and disinfectants. (15th) Immoderately. (16th) In public lavatories; in the river and in the houses. (17th) 40 days—ascend, 8; apogee, 20; descent, 12. (18th) No. (19th) Yes. (20th) 432 attacks—202 males, 230 females. (21st) 104 deaths—66 males, 38 females. (22d) Majority in the upper; more to the south than to the north. (23d) Five or six in the post of the civil guard. (24th) Total absence of hygiene.

*Muniesa*, 1,163 inhabitants.—(1st answer.) From the 18th of July to the 10th of September. (2d) By persons from infected places. (3d) The first ordinary; the second bad. (4th) There is none; excrement in court-yards for manure; the inhabitants clean. (5th) Fountain water brought  $1\frac{1}{2}$  kilometers; good and hard. (6th) Those who used other water. (7th) Sandy; at 50 meters, a meadow and a pool filled with rain water which stagnates; no fevers. (8th) At 300 meters. (9th) Of brick. (10th) Less than the former. (11th) On the side of a pool, Riquero. (12th) Most next to the pool. (13th) Neighboring roads. (14th) Cordons and some disinfectants. (15th) Abuse of fruits and vegetables. (16th) In public lavatories and in basins within the village; by each inhabitant. (17th) 55 days—ascend, 10; apogee, 30; descent, 15. (18th) Yes; descent 24 hours after rains and storms. (19th) No. (20th) 406 attacks—192 males, 214 females. (21st) 64 deaths—37 males, 27 females. (22d) The houses of the village are low. (23d) In the post of the civil guard double mortality in proportion to that of the town.

*Hijar*, 3,191 inhabitants.—(1st answer.) From the 18th of July to the 16th of August. (2d) Unknown; on the same day the epidemic occurred in the majority of the villages on the banks of the river Martin. (3d) Good. (4th) There is none; night soil emptied into the canal; the municipality cleans. (5th) From the river Martin; good. (6th) No. (7th) Limestone; no marshes nor fevers. (8th) At one kilometer. (9th) There is none. (10th) Former less; unknown. (11th) Upon the banks of the river Martin. (12th) The higher part suffered most. (13th) Highway; 1 kilometer distant from the railway. (14th) Disinfectants; the lazaratto near the village for the sick. (15th) Much. (16th) Washing only in the river. (17th) 29 days—ascend, 9; apogee, 10; descent, 10. (18th) Began with a storm and ended with another. (19th) Yes. (20th) 376 attacks—168 males, 208 females. (21st) 135 deaths—71 males, 64 females. (22d) Equally. (23d) No attack in the prison.

*Esteruel*, 986 inhabitants.—(1st answer.) From the 18th of July to the 6th of September. (2d) Imported by a woman. (3d) Ordinary. (4th) There is none; the inhabitants and the rain clean. (5th) Good spring water. (6th) No. (7th) Sand and clay; no marshes nor fevers. (8th) At 500 meters. (9th) There is none. (10th) This time greater than the former. (11th) At 100 meters. (12th) Double near the river. (13th) By land. (14th) Everything done imperfectly. (15th) Yes; abuse of salads and cucumbers. (16th) In the river. (17th) 51 days—ascend, 6; apogee, 33; descent, 12. (18th) No. (19th) No. (20th) 188 attacks—60 males, 128 females. (21st) 86 deaths—40 males, 46 females. (22d) No difference. (23d) There are none.

*Castelserás*, 1,923 inhabitants.—(1st answer.) From the 18th of July to the 19th of August. (2d) Supposed by water of the river Guadalupe. (3d) Both bad. (4th) A sewer; night soil into the court-yards. (5th) From the river and a fountain; good. (6th) Suspected. (7th) Sandy and clay; no marshes; there are ponds containing vegetable matter in a state of putrefaction. (8th) At 126 meters. (9th) Of brick. (10th) All the former together did not equal the force of this. (11th) At the confluence of two rivers. (12th) Equally. (13th) Neighboring roads. (14th) Disinfectants and prohibition of river water. (15th) Much. (16th) In the rivers. (17th) 33 days—ascend, 7; apogee, 3; descent, 23. (18th) Yes; began after a hurricane. (19th) No. (20th) 584 attacks—265 males, 319 females. (21st) 254 deaths—105 males, 149 females. (22d) Equally. (23d) There are none. (24th) The epidemic increased with rise in the level of the well water, and fell with the fall of the same; excessive humidity.

*La Ginebrosa*, 1,083 inhabitants.—(1st answer.) From the 19th of July to the 2d of September. (2d) Unknown. (3d) Both bad. (4th) No sanitary board; inhabitants are required to carry the night soil 1,300 meters away. (5th) Good springs. (6th) No. (7th) Good clay and limestone; no marshes nor fevers. (8th) 1,000 meters. (9th) None. (10th) Yes. (11th) Upon a hill. (13th) By land. (14th) All. (15th) No. (16th) In public lavatories; also in houses. (17th) 56 days—ascend, 18; apogee, 15; descent, 12. (18th) No. (19th) Yes. (20th)



128 attacks—65 males, 63 females. (21st) 47 deaths—21 males, 26 females. (22d) In the surrounding orchards, 7; in the village, 121; all in the upper stories. (23d) There are none.

*Oliete*, 1,884 inhabitants.—(1st answer.) From the 19th of July to the 8th of September. (2d) Unknown. (3d) Ordinary. (4th) There is none; cleaning by the inhabitants. (5th) Spring and river water; good, pleasant; containing magnesia. (6th) No. (7th) Clay; limestone. (8th) 110 meters. (9th) There is none. (10th) Equally. (11th) Ponds and river Martin. (12th) Equally. (13th) By land. (14th) Disinfectants. (15th) Abuse of cucumbers, tomatoes, and vegetables. (16th) In the river. (17th) 51 days—ascend, 20; apogee, 15; descent, 16. (18th) Yes; the same. (19th) No. (20th) 557 attacks—219 males, 338 females. (21st) 182 deaths—85 males, 97 females. (23d) In the post of the civil guard, where there were 35 persons, there were 7 attacks and 2 deaths.

*Villastar*, 712 inhabitants.—(1st answer.) From the 23d of July to the 19th of August. (2d) Suspected by water of the canal from the Guadalaviar. (3d) Both bad. (4th) There is none; the night soil is carried to the fields by laborers or transported by the municipality. (5th) Springs and canals; good. (6th) No. (7th) Clay; there are marshes and frequent fevers in spring and autumn. (8th) At 800 meters. (9th) There is none. (10th) This time much more. (11th) Upon two rivers. (12th) Indifferently. (13th) By land. (14th) Cordons and disinfectants. (15th) Abuse of vegetables; but little fruit. (16th) In the rivers. (17th) 28 days—ascend, 12; apogee, 9; descent, 7. (18th) Yes; mortality greater. (19th) No. (20th) 209 attacks—106 males, 103 females. (21st) 73 deaths—33 males, 40 females. (22d) In the lower stories, 40; in the upper, 33; to the north and south equally. (23d) There are none. (24th) Infected rivers near the village.

*Vinaceite*, 481 inhabitants.—(1st answer.) From the 24th of July to the 18th of August. (2d) By persons from infected places. (3d) Ordinary. (4th) There is none; cleaning by the municipality. (5th) From the river. (6th) From the river. (7th) Clay; fevers in spring; on a river. (8th) 150 meters. (9th) There is none. (10th) Much less this time. (11th) Upon a river. (12th) Equally. (13th) By land. (14th) Disinfectants. (15th) Abuse of fruits and vegetables. (16th) In the river. (17th) 25 days—ascend, 12; apogee, 6; descent, 7. (18th) Yes. (19th) Yes. (20th) 46 attacks—18 males, 28 females. (21st) 18 deaths—7 males, 11 females. (22d) All in the lower; majority to the north.

*Belmonte*, 936 inhabitants.—(1st answer.) From the 21st of July to the 2d of September. (2d) Imported by persons. (3d) Bad. (4th) There is none; the rains do the cleaning; no public service. (5th) Good spring water, containing lime and magnesia. (6th) No. (7th) Sand, clay; no marshes nor fevers. (8th) At 250 meters. (9th) Pipes of olive and elm wood. (10th) The epidemic of 1855 was less; in the last there was no cholera; attributed to isolation. (11th) At the confluence of several streams. (12th) Equally. (13th) By land. (14th) Cordons, lazarettos and disinfectants, but in small amount. (15th) Much. (16th) In public lavatories; generally in houses. (17th) 43 days—ascend, 16; apogee, 14; descent, 13. (18th) No. (19th) Yes. (20th) 205 attacks—101 males, 104 females. (21st) 49 deaths—23 males, 26 females. (22d) There are no upper stories; indifferently to the north and south. (23d) In the post of the civil guard there were 5 attacks. (24th) During the ascent 200 persons emigrated, and not one of these was attacked; choleraic diarrhoea was more frequent than malarial.

*La Cuba*, 453 inhabitants.—(1st answer.) From the 24th of July to the 19th of September. (2d) Imported by persons. (3d) The rain water descends from the cemetery to the village. (4th) There is none; the inhabitants and the municipality clean. (5th) Good spring and well water. (6th) Unknown. (7th) In a hollow surrounded by mountains; no marshes nor fevers. (8th) Adjoining the town. (9th) There is none. (10th) The former less severe. (11th) At the confluence of two streams. (12th) The lower part less affected. (13th) By land. (14th) All; good alimentary regimen. (15th) Entire abstention. (16th) In the public lavatories; during the cholera, in the river and in houses. (17th) 57 days—ascend, 17; apogee, 30; descent, 10. (18th) Yes; with evident increase of attacks and deaths. (19th) Yes; in general. (20th) 70 attacks—27 males, 43 females. (21st) 26 deaths—10 males, 16 females. (22d) All in upper and to the south. (23d) There are none.

*Mas de las Matas*, 2,043 inhabitants.—(1st answer.) From the 24th of July to the 1st of September. (2d) Imported by persons. (3d) Good. (4th) There is none; cleaning by the municipality. (5th) From the river and springs; good. (6th) No. (7th) Granite, clay; fevers not frequent. (8th) At 300 meters. (9th) There is none; water brought by canals. (10th) The epidemic of 1885 was a third less severe. (11th) The upper part of the village is surrounded by canals; at 300 meters from the river. (12th) Equally. (13th) Highways. (14th) All. (15th) Much; frequent colics. (16th) In public lavatories; canals of running water. (17th) 3 days—ascend, 39; apogee, 12; descent, 24. (18th) Yes; evidently. (19th) Yes. (20th) 564 attacks—240 males, 324 females. (21st) 117 deaths—47 males, 70 females. (22d) In the lower, 50; in the upper, 514; to the north, 204; to the south, 360. (23d) There are none. (24th) Hygiene is ordinary, and there is bad food.

*Camarillas*, 860 inhabitants.—(1st answer.) From the 25th of July to the 26th of August. (2d) Imported by persons. (3d) Good; that of the most ordinary. (4th) There is none; inhabitants clean their dung yards. (5th) Good spring water. (6th) Unknown. (7th) Granite; no marshes nor intermittent fevers. (8th) Near the village. (9th) Of brick. (10th) That of 1835 greater. (11th) Near a dry river. (12th) The part near the river was one-half more attacked. (13th) Highways. (14th) All. (15th) No. (16th) In the river and in houses. (17th) 31 days—apogee at the commencement and at the end. (18th) No. (19th) Yes. (20th) 9 attacks—2 males, 7 females. (21st) 8 deaths—2 males, 6 females. (22d) In the upper equally; in all directions. (23d) There are none. (24th) Slight; force of the cholera was attributed to good diet.

*Castellote*, 2,412 inhabitants.—(1st answer.) From the 25th of July to the 31st of August. (2d) Unknown. (3d) Good. (4th) There is none; no one charged with cleaning. (5th) Springs; medium quality. (6th) No. (7th) Limestone; calcareous; no marshes; very few fevers. (8th) At 1,000 meters. (9th) There is none. (10th) Former was greater. (11th) Village not near a river or stream. (13th) Highway. (14th) All. (15th) No. (16th) In public lavatories; during the cholera washed in the river and in pools. (17th) 37 days—descent little by little. (18th) No. (19th) Yes. (20th) 140 attacks—80 men and women, 60 children. (21st) 61 deaths—37 men, 14 women, 10 children. (22d) There are none. (23d) There are none.

*Alobras*, 489 inhabitants.—(1st answer.) From the 26th of July to the 27th of August. (2d) Unknown. (3d) Good. (4th) There is none; inhabitants clean. (5th) Springs good, containing lime and magnesia. (6th) No. (7th) Clay and limestone; surrounded by marshes; no fevers in the locality. (8th) At 300 meters. (9th) There is none. (10th) That of 1855 was greater. (11th) Upon two little streams. (12th) Equally. (13th) Highway. (14th) All. (15th) No; for there are no fruits. (16th) In the streams. (17th) 32 days—ascend, 11; apogee, 16; descent, 5. (18th) No. (19th) Yes. (20th) 25 attacks—10 males, 15 females. (21st) 16 deaths—4 males, 12 females. (22d) Equally in upper and lower; 15 to the north, 10 to the south. (23d) There are none.

*Foz Calanda*, 831 inhabitants.—(1st answer.) From the 26th of July to the 22d of September. (2d) Imported by persons. (3d) First good; second bad. (4th) There is none; cleaning by the municipality. (5th) Springs; good, containing carbonate of soda. (6th) No. (7th) Subsoil calcareous; no marshes nor fevers. (8th) At 2 kilometers. (9th) There is none. (10th) About the same. (11th) Upon a brook. (12th) In part removed from the river. (13th) Neighboring roads. (14th) All. (15th) No cause; there are none. (16th) In public lavatories; in springs and houses. (17th) 59 days—ascend, 23; apogee, 7; descent, 29. (18th) No. (19th) No. (20th) 101 attacks—31 males, 70 females. (21st) 51 deaths. (22d) The majority in upper and to the south. (23d) There are none.

*Bello*, 906 inhabitants.—(1st answer.) From the 26th of July to the 27th of August. (2d) Imported by persons. (3d) Bad; the village at 1 kilometer from Lake Gallocanda; productive of intermittent fevers; the houses bad. (4th) There is none; no one charged with cleaning. (5th) Wells; medium quality. (6th) No. (7th) Calcareous, subsoil clay; fevers frequent in spring and autumn. (8th) At 464 meters. (9th) No. (10th) The former were less severe. (11th) In a plain without trees. (12th) Began in the part near the lake. (13th) Highway.



(14th) Nothing. (15th) Little abuse. (16th) In the houses. (17th) 32 days—ascend, 12; apogee, 8; descent, 12. (18th) No. (19th) Yes. (20th) 321 attacks—143 males, 178 females. (21st) 77 deaths—32 males, 45 females. (22d) Equally; to the north, 132; to the south, 89; to the east, 37; to the west, 73. (23d) There are none.

*Villalba Alta*, 280 inhabitants.—(1st answer.) From the 27th of July to the 2d of September. (2d) Imported by persons. (3d) Ordinary; in general. (4th) There is none; public cleaning wanting. (5th) Good spring and river water. (6th) From the river. (7th) Clay; no marshes nor fevers. (8th) Near the village. (9th) No; there is a natural canal. (10th) The anterior less benign. (11th) Near the river and surrounded by brooks. (12th) More in the center of the town. (13th) Neighboring roads. (14th) Cordons, disinfectants. (15th) No. (16th) In the streams and rivers; washing in the houses also. (17th) 38 days—ascend, 7; apogee, 3; descent, 28. (18th) Rains and winds two days. (19th) Yes. (20th) 11 attacks—5 males, 6 females. (21st) 7 deaths—3 males, 4 females. (22d) in the upper, 8; the remainder in the lower; to the south, 7; to the north, 4. (23d) No. (24th) The soil is very moist; there is a tendency to typhoid.

*Alfambra*, 1,318 inhabitants.—(1st answer.) From the 27th of July to the 1st of September. (2d) By persons. (3d) Houses of the first attack bad; ordinary and general. (4th) There is none; cleaning by individuals. (5th) Good river water. (6th) No. (7th) Clayey; no marshes. (8th) At 400 meters. (9th) No; there are uncovered canals. (10th) The former were greater. (11th) Near the river. (12th) Greater near the river. (13th) Highways. (14th) Both. (15) Abuse of vegetables. (16th) No public lavatories in the village. (17th) 35 days—ascend, 13; apogee, 15; descent, 7. (18th) No. (19th) No. (20th) 103 attacks—43 males, 60 females. (21st) 32 deaths—11 males, 21 females. (22d) In the lower, 80; in the upper, 23; to the north, 30; to the south, 73. (23d) In the post of the civil guards, 4 attacks and 2 deaths.

*Albarracin*, 2,134 inhabitants.—(1st answer.) From the 27th of July to the 29th of August. (2d) Imported by persons. (3d) Ordinary; small and little ventilation. (4th) There is none; no public cleaning. (5th) River and spring water; good, containing lime. (6th) Yes; by use of the river water below Torres, an infected point, for in this river the clothing of that village was washed. (7th) Calcareous; no marshes or fevers. (8th) At 200 meters. (9th) A short trench of brick. (10th) In 1855 greater; in 1865 there was none—attributed to isolation; in 1855 not known what measures were taken to prevent it. (11th) Upon a rock surrounded by the river at Guadalaviar. (12th) None near the river; only in the center of the village; less in the high part of the village. (13th) Neighboring roads. (14th) All. (15th) Abstention during the epidemic. (16th) In the river and in the lavatories; during the epidemic the clothing of the sick was washed in the river; the rest of the clothing was washed in the fountains. (17th) 33 days—ascend, 7; apogee, 5; descent, 21. (18th) No; coincided with the greatest heat. (19th) Yes. (20th) 17 attacks—6 males, 11 females. (21st) 5 deaths—3 males, 2 females. (22d) In the lower, 5; in the upper, 12. (23d) No attacks in the prison nor in the post of the civil guards.

*Parras de Castellote*, 1,210 inhabitants.—(1st answer.) From the 29th of July to the 5th of September. (2d) Imported by persons. (3d) Both good. (4th) Open sewers; cleaning by the municipality. (5th) Good, containing lime. (6th) No. (7th) Sandy and limestone; no marshes nor intermittent fevers. (8th) At 600 meters. (9th) Of brick. (10th) That of 1855 was greater; not known why. (11th) Upon two ravines. (12th) Equally. (13th) Neighboring roads. (14th) All; disinfectants in small quantities. (15th) No. (16th) No lavatories. (17th) 39 days—ascend, 10; apogee, 9; descent, 20. (18th) No rain, but there were fogs. (20th) Unknown. (21st) 81 attacks—43 males, 38 females. (22d) Not known. (23d) There are none.

*Vallarquemado*, 865 inhabitants.—(1st answer.) From the 29th of June to the 26th of August. (2d) Imported by persons. (3d) Good; meadows overflowed in winter. (4th) There is none; cleaning by the inhabitants. (5th) Good, river water. (6th) No. (7th) Clayey and sandy; in rainy years there are marshes, and fevers in the summer and autumn. (8th) At 1 kilometer. (9th) There is none. (10th) Equally. (11th) On the plain; the river Cellato to the west. (12th) The part near the river 26 per cent. more. (13th) By river and highway. (14th) All. (15th)

No. (16th) In a canal and in the houses. (17th) 27 days—ascend, 3 ; apogee, 8 ; descent, 16. (18th) Yes. (19th) Yes. (20th) 101 attacks—51 males, 50 females. (21st) 31 deaths—14 males, 17 females. (22d) In the lower, 90 ; in the upper, 11 ; to the south, 62 ; to the north, 29. (23d) In the post of the civil guard there were a few cases.

*Berriente*, 2,069 *inhabitants*.—(1st answer.) From the 29th of July to the 12th of September. (2d) By persons from infected places. (3d) The first ordinary ; the second very bad. (4th) There is none ; cleaning by the inhabitants. (5th) Springs good and hard ; containing magnesia. (6th) No. (7th) Sandy ; no marshes nor fevers. (8th) At 100 meters. (9th) There is none. (10th) Less this time. (11th) Highways. (12th) Cordons before the epidemic. (13th) No. (14th) In a spring by each family. (15th) 45 days—ascend, 15 ; apogee, 10 ; descent, 20. (16th) Changed with cold. (17th) No. (18th) 277 attacks—120 males, 157 females. (19th) 46 deaths—15 males, 31 females. (20th) Always one story.

*Navarrete*, 507 *inhabitants*.—(1st answer) From the 1st to the 30th of August. (2d) Imported by persons and effects. (3d) The village good ; the houses ordinary. (4th) There is none ; cleaning by the inhabitants who please. (5th) Good spring water. (6th) Not known ; supposed none. (7th) Sand and gravel ; no fevers. (8th) At 900 meters ; traversed by the river. (9th) Of brick, short. (10th) There was no cholera ; supposed due to isolation. (11th) At 300 meters from the river. (12th) Equally. (13th) Neighboring roads. (14th) Cordons and disinfectants. (15th) Little ; salads and peppers. (16th) In the houses and in the public lavatories ; during the epidemic in the river. (17th) 30 days—ascend, 10 ; apogee, 10 ; descent, 10. (18th) With a storm which lasted two or three days. (19th) Yes. (20th) 45 attacks—15 males, 30 females. (21st) 15 deaths—5 males, 10 females. (22d) Equally. (23d) There are none.

*Bádenas*, 498 *inhabitants*.—(1st answer.) From the 2d to the 31st of August. (2d) Imported by persons. (3d) Ordinary. (4th) There is none ; cleaning by the inhabitants. (5th) Good spring water. (6th) No. (7th) Good ; clayey ; no marshes nor fevers. (8th) Of brick. (9th) Less than this. (10th) Upon the banks of two streams. (11th) Equally. (12th) By land. (13th) All. (14th) No. (15th) In running water beyond the village. (16th) 29 days—ascend, 12 ; apogee, 7 ; descent, 10. (17th) Yes ; maximum mortality with storm. (18th) Yes. (19th) 81 attacks. (20th) 18 deaths. (21st) In the lower, 51 ; in the upper, 30 ; all to the north. (22d) There are none.

*Sarrión*, 2,477 *inhabitants*.—(1st answer.) Some isolated cases from the 24th of June, but the epidemic did not begin until the 2d of August. (2d) Imported by persons from infected places. (3d) First good ; second dirty. (4th) There is none ; cleaning by the inhabitants. (5th) Fountain water from springs, good and somewhat hard ; agreeable. (6th) Houses which used a fountain surrounded by pools from April to May. (7th) Clay and limestone predominant ; no marshes nor fevers. (8th) At 1 kilometer. (9th) There is none. (10th) In 1855 less. (11th) No ; upon a solid rock. (12th) In the part near the fountain. (13th) Highways. (14th) All. (15th) No. (16th) In public lavatories ; each house its own. (17th) 40 days—ascend, 14 ; apogee, 12 ; descent, 14. (18th) There were fogs. (19th) Yes. (20th) 305 attacks—145 males, 160 females. (21st) 124 deaths—51 males, 73 females. (22d) All in the lower, and more to the south. (23d) In the post of the civil guard—4 attacks and 2 deaths ; the force numbered 11.

*Mazaleón*, 1,122 *inhabitants*.—(1st answer.) From the 2d of August to the 2d of September. (2d) Unknown. (3d) Both good. (4th) There is none ; cleaning by the municipality ; excrement in the court-yards. (5th) Good, river water. (6th) No. (7th) Clayey ; no marshes ; fevers frequent in winter. (8th) At 100 meters. (9th) There is none. (10th) The former less intense. (11th) Upon a river. (12th) Less in the higher portions. (13th) By land. (14th) Cordons. (15th) No. (16th) In the river. (17th) 31 days—ascend, 6 ; apogee, 15 ; descent, 10. (18th) No. (19th) Yes. (20th) 142 attacks—54 males, 88 females. (21st) 56 deaths—26 males, 30 females. (22d) The majority in the lower, and to the north. (23d) There are none.

*Mora de Rubielos*, 3,283 *inhabitants*.—(1st answer.) From the 3d of August to the 7th of September. (2d) Unknown. (3d) Both bad. (4th) There is none ; cleaning by the municipi-



pality. (5th) Springs. (6th) No. (7th) Surrounded by a river; sandy soil. (8th) At 1 kilometer. (9th) Of brick. (10th) 337 attacks in the year 1855. (11th) Upon the banks of a river. (12th) In the proportion of 75 to 80 per cent. (13th) Highway. (14th) Cordons, lazarettos, and disinfectants, and boiling of clothes. (15th) No. (16th) In public lavatories, rivers, and streams. (17th) 35 days—ascend, 11; apogee, 13; descent, 11. (18th) They coincided. (19th) Yes. (20th) 54 attacks—32 males, 22 females. (21st) 32 deaths—18 males, 14 females. (22d) In the lower, 10; the rest in the upper.

*Ojos-Negros*, 1,199 inhabitants.—(1st answer.) From the 3d of August to the 11th of September. (2d) Contagion by persons from infected places. (3d) Both bad. (4th) There is none; great filth in general. (5th) Two fountains supplied by springs; good; containing lime. (6th) By contagion. (7th) Clay and limestone. (8th) Adjoining, to the north. (9th) Of brick. (10th) In the year 1885 there were triple the invasions; in 1865 not an attack. (11th) Dry soil. (12th) The lower part of the village was most attacked. (13th) Highway. (14th) Disinfectants and cordons. (15th) Fruits; no vegetables; yes. (16th) In the houses and in a brook at 1 league. (17th) 39 days—ascend, 19; apogee, 8; descent, 12. (18th) No. (19th) Yes. (20th) 188 attacks—67 males, 121 females. (21st) 42 deaths—19 males, 23 females. (22d) In the lower, 20; in the upper, 169; houses to the north, 40; houses to the south, 100.

*Santa Cruz de Noguera*, 319 inhabitants.—(1st answer.) From the 4th to the 25th of August. (2d) Unknown. (3d) In general, good; the houses of the first attack badly constructed and damp. (4th) There is none; public cleaning, miserable. (5th) Good spring water. (6th) Unknown. (7th) Rocky; no marshes nor fevers. (8th) At 1 kilometer. (9th) Of stone. (10th) Was less attacked, without taking any measures of precaution. (11th) Open and hilly; near a river, at 500 meters distance. (12th) Yes; three-fourths more. (13th) Highway. (14th) All. (15th) No. (16th) In the river; during the epidemic the same. (17th) 21 days—ascend, 5; apogee, 4; descent, 12. (18th) Yes, after rain. (19th) Yes. (20th) 46 attacks—23 males, 23 females. (21st) 19 deaths—8 males, 11 females. (22d) In the lower and to the south, 30; to the north, 16. (23d) There are none.

*Gea*, 1,684 inhabitants.—(1st answer.) From the 4th to the 31st of August. (2d) Unknown. (3d) Medium. (4th) There is none; cleaning by the inhabitants. (5th) From the river, and good spring water. (6th) No. (7th) Clay and limestone; no marshes or fevers. (8th) At 300 meters. (9th) There is none. (10th) More. (11th) Upon a river. (12th) Equally. (13th) Highways. (14th) Cordons and lazarettos. (15th) No. (16th) Few go to wash in the river. (17th) 27 days—ascend, 5; apogee, 4; descent, 18. (18th) No. (19th) Yes. (20th) 120 attacks—50 males, 70 females. (21st) 25 deaths—7 males, 18 females. (22d) Unknown.

*Monforte*, 668 inhabitants.—(1st answer.) From the 4th of August to the 1st of September. (2d) By persons from infected places. (3d) First, good; second, bad. (4th) There is none; cleaning by the municipality. (5th) Springs; good and pleasant. (6th) No. (7th) Granite; no marshes nor fevers. (8th) At 1 kilometer. (9th) Of brick. (10th) Less this time. (11th) No. (12th) To the North. (13th) By land. (14th) Cordons and disinfectants. (15th) No. (16th) In public lavatories. (17th) 28 days—ascend, 6; apogee, 14; descent, 8. (18th) No. (19th) Yes. (20th) 94 attacks—50 males, 44 females. (21st) 50 deaths—29 males, 21 females. (22d) Lower, 28; upper, 17; to the north, 15; to the south, 34. (23d) In the post of the civil guards, no attack.

*Torre de los Arcos*, 528 inhabitants.—(1st answer.) From the 5th of August to the 9th of September. (2d) By communication with persons from infected places. (3d) First good; second ordinary. (4) There is none; night-soil in the court-yards; cleaning by the inhabitants. (5th) River water proceeding from a spring; agreeable; soft, containing lime. (6th) No. (7th) Sandy; clay and limestone; no marshes, and no intermittent fevers. (8th) Within the village. (9th) There is none. (10th) More this time. (11th) At 50 meters from the river. (12th) Almost all near the river. (13th) By land. (14th) Cordons and some disinfectant. (15th) Abuse of salads, tomatoes, and peppers. (16th) In the river; each family washes its own. (17th) 35 days—ascend, 12. (18th) Yes. (19th) No. (20th) 10 attacks. (21st) 7 deaths—4 males, 3 females. (22d) In the lower; to the south 5; to the north 5.

*La Rambla*, 122 *inhabitants*.—(1st answer.) From the 5th to the 13th of August. (2d) Unknown. (3d) Bad; the same in the houses. (4th) There is none; cleaning by the inhabitants. (5th) Good river water, containing lime. (6th) No. (7th) Clay; no marshes nor fevers. (8th) At 1,000 meters. (9th) There is none. (10th) No previous epidemics. (11th) At 40 meters from the river. (12th) By 11 to 4. (13th) Highways. (14th) Cordons and disinfectants; the fumes of *succinum nigrum* (L.). (15th) No. (16th) In the house, in the river, and in the canal; in public lavatories. (17th) 8 days—ascend, 2; apogee, 1; descent, 5. (18th) No. (19th) Yes. (20th) 35 attacks—17 males, 18 females. (21st) 15 deaths. (22d) All in the lower. (23d) There are none. (24th) Applied ligatures to the legs after enveloping in woolen cloths, for the purpose of avoiding cramps.

*Molinos*, 1,381 *inhabitants*.—(1st answer.) From the 5th to the 31st of August. (2d) Unknown. (3d) Houses good; those of the first attacked bad. (4th) There is none; cleaning by the inhabitants. (5th) Good spring water. (6th) No. (7th) Surrounded by limestone and granitic mountains; no marshes nor fevers. (8th) At 1,000 meters. (9th) There is none. (10th) That of 1855 was the greatest of all. (11th) A small river traverses the village; another smaller one flows to the east. (12th) The portion near the river suffered most, by 30 per cent. (13th) Highways. (14th) Cordons by day. (15th) No. (16th) In running river water and canal water. (17th) 26 days—ascend, 10; apogee, 8; descent, 8. (18th) No. (19th) No. (20th) 188 attacks—98 males, 90 females. (21st) 77 deaths—39 males, 38 females. (22d) To the north, 33; to the south, 4. (23d) There are none.

*Villarroya de los Pinares*, 1,114 *inhabitants*.—(1st answer.) From the 6th of August to the 12th of September. (2d) Imported. (3d) Bad; the village is traversed by a river, which produces constant dampness. (4th) There is none; cleaning by the inhabitants. (5th) Good spring water. (6th) No. (7th) Sandy; a few marshes; malarial fever frequent in autumn. (8th) Not very distant, but elevated. (9th) There is none. (10th) In the year 1855 it was less intense. (11th) Surrounded by a river. (12th) Double the number of attacks near the river; the part most elevated and distant from the river less attacked. (13th) By land. (14th) All. (15th) No. (16th) In the river. (17th) 37 days—ascend, 12; apogee, 14; descent, 11. (18th) No; but during the apogee a tendency to cold. (19th) Yes. (20th) 200 attacks—60 males, 140 females. (21st) 38 deaths—14 males, 24 females. (22d) All in the upper; double in the houses to the south. (23d) There is none.

*Visiedo*, 674 *inhabitants*.—(1st answer.) From the 7th to the 28th of August. (2d) Unknown. (3d) Dampness predominates; in general healthy. (4th) There is none; cleaning by the inhabitants. (5th) Good spring water. (6th) No. (7th) Sandy; no marshes nor fevers. (8th) At 250 meters. (9th) Of brick. (10th) There have been none. (11th) In a small plain. (12th) Equally. (13th) Neighboring roads. (14th) All. (15th) No; because there is none. (16th) In basins and small streams. (17th) 21 days—ascend, 8; apogee, 2; descent, 11. (18th) No. (19th) No. (20th) 57 attacks—24 males, 33 females. (21st) 21 deaths—6 females, 15 males. (22d) In the lower, 22; in the upper, 35; to the north, 4; to the south, 53. (23d) There are none.

*Martin del Rio*, 578 *inhabitants*.—(1st answer.) From the 8th to the 28th of August. (2d) Imported. (3d) Good. (4th) There is none; the municipality cleans. (5th) Good spring and river water. (6th) That proceeding from the river, which passed along the infected villages. (7th) Clay; fevers infrequent. (8th) At 445 meters. (9th) There is none. (10th) The former less intense. (11th) Near the river and irrigation canal. (12th) That nearest the river and the lowest part of the village. (13th) By land. (14th) Cordons. (15th) No. (16th) In the river. (17th) 20 days—ascend, 8; apogee, 2; descent, 10. (18th) Yes. (19th) Yes. (20th) 60 attacks—22 males, 38 females. (21st) 41 deaths—12 males, 29 females.

*Cabra de Mora*, 624 *inhabitants*.—(1st answer.) From the 8th of August to the 11th of September. (2d) The first attacked had not left the village. (3d) Ordinary. (4th) There is none; cleaning by the inhabitants. (5th) Good river water. (6th) No. (7th) Sandy and clayey; no fevers. (8th) In the center. (10th) More in the former. (11th) Upon the river. (12th) Part most distant from the river. (13th) By land. (14th) All. (15th) No. (16th) In the lavatories. (17th) 34 days. (18th) Normal weather. (19th) Yes. (20th) 36 attacks.



(21st) 8 deaths. (22d) 36 in the lower stories; to the north, 13; to the south, 23. (24th) The poor suffered most.

*Fuentes de Rubielos*, 964 inhabitants.—(1st answer.) From the 9th to the 30th of August. (2d) Unknown. (3d) Good; houses of the attacked bad. (4th) There is none; cleaning by the municipality. (5th) Good spring water, containing lime and magnesia. (6th) No. (7th) Good; sandy and granitic; no marshes nor fevers. (8th) At 140 meters. (9th) There is none. (10th) The former greater. (11th) Upon two springs. (12th) The southern part suffered most. (13th) Highways. (14th) All. (15th) Yes. (16th) In public lavatories. (17th) 21 days—ascend, 10; apogee, 4; descent, 7. (18th) No. (19th) Yes. (20th) 38 attacks—15 males, 23 females. (21st) 19 deaths—9 males, 10 females. (22d) In the lower, 7; in the upper, 31; to the south, 36; to the north, 2. (23d) There are none.

*Linares*.—(1st answer.) From the 9th of August to the 19th of September. (2d) Imported by persons. (3d) Good; the houses first attacked ordinary. (4th) There is none; cleaning by the inhabitants. (5th) Good spring water, containing lime. (6th) No. (7th) Clay and limestone; no marshes nor fevers. (8th) At 100 meters. (9th) Of brick. (10th) Equally. (11th) At confluence of two streams. (12th) Equally. (13th) Highways. (14th) All. (15th) No; the use of salads predominates. (16th) In public lavatories. (17th) 41 days. (18th) No. (19th) Yes. (20th) 29 attacks—14 males, 15 females. (21st) 13 deaths—5 males, 8 females. (22d) All in the upper and to the south. (23d) There are none.

*Cuevas de Portal-Rubio*, 199 inhabitants.—(1st answer.) From the 9th to the 24th of August. (2d) Unknown. (3d) Both bad. (4th) There is none; cleaning by the inhabitants. (5th) Good river water, containing lime. (6th) No. (7th) Calcareous; no marshes nor fevers. (8th) At 1,000 meters. (9th) There is none. (10th) Epidemics were unknown. (11th) At 60 meters from the river. (14th) Cordons; disinfectants, consisting of fumes of the succinum nigrum (L.). (15th) Very little. (16th) Washing in the house. (17th) 14 days—ascend, 2; apogee, 2; descent, 10. (18th) No. (19th) Yes. (20th) 12 attacks—4 males, 8 females. (21st) 9 deaths. (22d) All in the lower and to the south. (23d) There are none.

*Rubielos de Mora*, 305 inhabitants.—(1st answer.) From the 12th of August to the 4th of October. (2d) Imported. (3d) Good, but there is much carelessness among the poor. (4th) The sewerage consists of canals, which run in all the streets; cleaning by the inhabitants; night-soil in the court-yards. (5th) Good spring water. (6th) No. (7th) Clay; a mountain intercepts the sun's rays a great part of the day; there are marshes; no intermittent fevers. (8th) Upon a mountain and at half a kilometer distance. (9th) Of brick. (10th) That of 1854 the same as this; the greatest number of streets and wards was attacked; the houses were examined in order to prevent the invasion. (11th) Upon the banks of a small river. (12th) Near the river 30 per cent. more attacks and 90 per cent. more deaths. (13th) By land. (14th) Isolation and disinfectants. (15th) No. (16th) In public lavatories and in the houses. (17th) 53 days—ascend, 17; apogee, 8; descent, 28. (18th) Yes; the number of attacks increased from 34 to 79 and the deaths from 7 to 18. (19th) No. (20th) 450 attacks—212 males, 238 females. (21st) 130 deaths—58 males, 72 females. (22d) Equally. (23d) In the post of the civil guard there were 8 attacks and 5 deaths among 18 persons. (24th) The force of the epidemic was among the lower classes, by reason of carelessness.

*Blancas*, — inhabitants.—(1st answer.) From the 12th of August to the 15th of September. (2d) Imported by persons. (3d) Both bad. (4th) There is none; cleaning by the inhabitants. (5th) Good spring water; containing lime. (6th) No. (7th) Clay and limestone; no marshes nor fevers. (8th) At 500 meters. (9th) Of brick. (10th) Greater in 1855. (13th) Neighboring roads. (14th) Nothing. (15th) No. (16th) In public lavatories; usually also in the houses. (17th) 34 days—ascend, 8; apogee, 9; descent, 17. (18th) No. (19th) No. (20th) 99 attacks—37 males, 62 females. (21st) 25 deaths—12 males, 13 females. (22d) All in the upper. (23d) There are none.

*Alcaine*, 1,615 inhabitants.—(1st answer.) From the 14th of August to the 25th of September. (2d) Imported by persons. (3d) Ordinary; especially the houses of the first attack. (4th) There is none; cleaning by the rains. (5th) River, spring, and rain water; soda, potassa, and magnesia. (6th) Good. (7th) Unknown; calcareous; there are marshes and fevers. (8th)

At half an hour's distance from the village. (9th) There is none. (10th) Equally. (11th) Upon a river; at 60 meters distance. (12th) About 10 per cent. (13th) Highway. (14th) Cordons and disinfectants. (15th) No. (16th) In the river; no lavatories. (17th) 42 days—ascend, 14; apogee, 10; descent, 18. (18th) No. (19th) Yes. (20th) 183 attacks—81 children, 83 adults, 10 aged. (22d) In the lower; little ventilation. (23d) There is none.

*Aliaga, 1,071 inhabitants.*—(1st answer.) From the 14th to the 31st of August. (2d) By effects from infected places. (3d) Both bad. (4th) There is none; cleaning by the inhabitants. (5th) Spring and river water; good. (6th) No. (7th) No marshes nor fevers. (8th) At 300 meters. (9th) Of brick. (10th) That of 1855 greater. (11th) At the confluence of two rivers. (12th) The upper portion suffered most, by 5 per cent. (13th) By land. (14th) Nothing. (15th) Abuse of salads and fruits. (16th) In the house. (17th) 17 days. (18th) No. (19th) Yes. (20th) 31 attacks—16 males, 15 females. (21st) 8 deaths—5 males, 3 females. (22d) All in the lower and to the east. (23d) In the post of the civil guards there was no attack; in the prison there were 3 attacks and 1 death. (24th) A family proceeding from Valencia, which had been attacked by the cholera, washed their clothing in the river Guadalupe; two days afterwards the epidemic began in the village of Pilar and also in other places near the river.

*Villar del Salz, 397 inhabitants.*—(1st answer.) From the 16th to the 31st of August. (2d) Unknown. (3d) All ordinary. (4th) There is none; cleaning by the municipality. (5th) Good spring water, containing lime and magnesia. (6th) Not suspected. (7th) Sandy and calcareous. (8th) At 400 meters. (9th) There is none. (10th) Equally. (11th) Upon a small stream. (12th) Unknown. (13th) Highways. (14th) Cordons and lazarettos. (15th) No. (16th) Outside of the house and in the stream. (17th) 16 days—ascend, 5; apogee, 2; descent, 9. (18th) No. (19th) Yes. (20th) 34 attacks—17 males, 17 females. (21st) 19 deaths—13 males, 6 females. (22d) In the lower, 19; in the upper, 15; to the south, 16; to the east, 11; to the west, 7. (23d) There is none.

*Fortanete, 1,647 inhabitants.*—(1st answer.) From the 17th of August to the 16th of September. (2d) Unknown. (3d) Bad. (4th) There is none; no public cleaning. (5th) Medium spring water, containing magnesia. (6th) No. (7th) Calcareous; no marshes nor fevers. (8th) At 500 meters. (9th) There is none. (10th) Equal to that of 1855. (11th) Upon the bank of the Guadalupe. (12th) By 6 to 1. (13th) Highway. (14th) Cordons and disinfectants. (15th) Little. (16th) Washing in the house. (17th) 30 days—ascend, 4; apogee, 21; descent, 5. (19th) Yes. (20th) 57 attacks—30 males, 27 females. (21st) 15 deaths—4 males, 11 females. (22d) The lower stories are not inhabited.

*Celadas, 824 inhabitants.*—(1st answer.) From the 18th of August to the 4th of September. (2d) Unknown. (3d) Both bad. (4th) There is none; night-soil in the public streets; only those interested charged with cleaning. (5th) All springs. (6th) No. (7th) Clay; no marshes nor intermittent fevers. (8th) At 600 meters. (9th) Of brick. (10th) This time less. (11th) There is no river or stream. (13th) By land. (14th) Cordons and disinfectants. (15th) No. (16th) In basins and pools. (17th) 17 days—ascend, 5; apogee, 5; descent, 7. (18th) Unknown. (19th) Choleriform cases before the cholera. (20th) 22 attacks—8 males, 14 females. (21st) 6 deaths—3 males, 3 females. (22d) In the lower, and the majority to the south. (23d) There are none. (24th) Rejected attention of the physicians.

*Cuevas de Cañarte, 870 inhabitants.*—(1st answer.) From the 18th of August to the 24th of September. (2d) Unknown. (3d) Good. (4th) Night-soil kept in the house; no public cleaning. (5th) Good spring water. (6th) No. (7th) Rock; limestone. (8th) At 300 meters. (9th) Of brick. (10th) That of 1855 greater. (11th) Surrounded by springs and meadows. (12th) Equally.

*Fórnoles, 817 inhabitants.*—(1st answer.) From the 19th of August to the 19th of September. (2d) Imported by persons from infected places. (3d) Bad; houses very bad. (4th) There is none; cleaning by the inhabitants. (5th) All spring water. (6th) No. (7th) Calcareous; no marshes nor fevers. (8th) Near the village. (9th) There is none. (10th) That of 1855 same as this; neither very intense. (11th) At the confluence of streams. (12th) Equally. (13th) Highways. (14th) Cleaning of the streets and houses; cordons and lazarettos. (15th)



There is no surrounding arable ground. (16th) Public lavatories. (17th) 31 days—ascend, 12; apogee, 2; descent, 17. (18th) Yes; evidently. (19th) Yes. (20th) 56 attacks—33 males, 23 females. (21st) 11 deaths—5 males, 6 females. (22d) In the lower; to the north, 33; to the south, 22. (23d) There are none.

*Cortes de Aragón*, 514 inhabitants.—(1st answer.) From the 23d of August to the 10th of September. (2d) Unknown. (3d) Some good; others bad. (4th) There is none; cleaning by the inhabitants. (5th) Good spring water. (7th) Hilly. (8th) At 300 meters. (9th) Of brick. (10th) Less; in 1856 no cases occurred. (11th) No. (13th) Neighboring highways. (14th) Cordons and disinfectants. (15th) No. (16th) In running water. (17th) 18 days—ascend, 4; apogee, 6; descent, 8. (19th) Yes. (20th) 50 attacks—30 males, 20 females. (21st) 7 deaths—3 males, 4 females. (22d) In the lower, 42; in the upper, 8.

*Villahermosa*, 249 inhabitants.—(1st answer.) From the 24th of August to the 11th of September. (2d) By effects and persons. (3d) Good; the houses of the first attack bad. (4th) There is no public service for cleaning. (5th) Good river water. (6th) No. (7th) Sand and granite; no marshes nor fevers. (8th) Near the village. (9th) There is none. (10th) The former greater. (11th) Upon the river Tuerva. (12th) The part near the river a third more. (13th) Neighboring highways. (14th) Disinfectants. (15th) Much. (16th) In the river. (17th) 19 days. (18th) No. (19th) Yes. (20th) 15 attacks—9 males, 6 females. (21st) 8 deaths—4 males, 4 females. (22d) In the lower, 4; in the upper, 4; none to the north. (23d) There are none.

*Mosqueruela*, 3,101 inhabitants.—(1st answer.) From the 24th of August to the 10th of September. (2d) Imported by persons. (3d) Some bad. (4th) There is none; cleaning by the inhabitants. (5th) Spring water. (6th) No. (7th) Sand and clay; there are no marshes, but there are fevers. (8th) At 11 meters. (9th) Of brick. (10th) In 1855 there were 800 attacks, and hygiene was wanting; in the other years there was not a case. (11th) There is neither a river nor a stream. (13th) Neighboring roads. (14th) Cordons badly placed; lazarettoes and disinfectants. (15th) No. (16th) In public lavatories. (17th) 17 days. (18th) Yes; evidently. (19th) Yes. (20th) 76 attacks—24 males, 52 females. (21st) 23 deaths—8 males, 15 females. (22d) All in the upper; to the south, 48; to the north, 28. (23d) In the post of the civil guard, one attack. (24th) The fulminant cases cured.

*Navarrete*, 506 inhabitants.—(1st answer.) From the 2d of September to the 2d of October. (2d) Imported by persons. (3d) Good; the second bad. (4th) There is none; cleaning by the inhabitants. (5th) Good fountain water; some from a well medium. (6th) No. (7th) Sandy; there are marshes and few fevers. (8th) At 96 meters. (10th) The epidemics are here benign. (11th) Near a stream. (12th) Equally. (13th) Highways. (14th) Disinfectants. (15th) No. (16th) In the stream. (17th) 30 days. (18th) No. (19th) Yes. (20th) 41 attacks—17 males, 24 females. (21st) 9 deaths. (22d) In the lower; to the south, 16; to the north, 25.

#### PROVINCE OF ALBACETE.

*Villatoya*, 304 inhabitants.—(1st answer.) From the 21st of June to the 24th of July. (2d) Suspected communication with infected places; not known. (3d) Both bad. (4th) There is none; cleaning by the municipality. (5th) The drinking water comes from the river Gabriel, and at 200 meters from the town. (6th) No. (7th) Clay; no marshes; few fevers. (8th) At 600 meters. (9th) There is none. (10th) This time more. (11th) At 200 meters from the river Gabriel. (12th) Equally. (13th) Highways. (14th) Disinfectants. (15th) Abuse of fruits and vegetables. (16th) In the streams and at 200 meters from the town. (17th) 34 days—ascend, 13; apogee, 2; descent, 19. (18th) Development coincided with storms; the maximum mortality with good weather. (19th) Yes. (20th) 32 attacks. (21st) 21 deaths—14 males, 7 females. (22d) All in the lower and equally to the north and south.

*Jorquera*, 2,514 inhabitants.—(1st answer.) From the 27th of June to the 12th of September. (2d) Not known for certain; attributed to the river Júcar. (3d) Good; on the banks of the Júcar. (4th) There is none; night-soil carried beyond the village in carts. (5th) Springs; at 1 kilometer from the village. (6th) Those first attacked used the water of the river Valdegayango.

(7th) Calcareous ; malarial fevers rare. (8th) At 250 meters. (9th) Of terra cotta and some of lead. (10th) This time less than in 1855. (11th) Upon the river Júcar. (12th) Indifferently. (13th) By land. (14th) Isolation preferred. (15th) Abuse of fruits by necessity. (16th) Washed in the source of a stream at the foot of the mountain beyond the village ; and the water goes to the river. (17th) 77 days ; anomalous course ; at the end of June, 6 cases ; at the end of July and the 1st of August, some ; considerable development of the epidemic in the second half of August. (18th) The epidemic appeared with great and continuous storms. (19th) Attacks of cholera and intestinal trouble. (20th) 215 attacks—85 males, 130 females. (21st) 71 deaths—26 males, 45 females. (22d) All in one story and to the south.

*Alcalá de Júcar, 2,763 inhabitants.*—(1st answer.) From the 1st of July to the 25th of August. (2d) By effects. (3d) First bad ; second miserable. (4th) There is none ; cleaning by the municipality and the inhabitants. (5th) Use the Júcar water ; good and pleasant. (6th) No. (7th) Good ; granite ; no marshes or frequent fevers. (8th) At 300 meters. (9th) There is none. (10th) That of 1834 greater than this. (11th) On the bank of the Júcar. (12th) Suffered most in the higher part. (13th) By land. (14th) Nothing ; only exquisite hygiene. (15th) No. (16th) In the river. (17th) 55 days—ascend, 10 ; apogee, 14 ; descent, 31. (18th) Not observed. (19th) Yes. (20th) 139 attacks—70 males, 69 females. (21st) 93 deaths—44 males, 49 females. (22d) All in the lower end to the south. (23d) There are none.

*Albacete, 18,038 inhabitants.*—(1st answer.) From the 15th of July to the 31st of August. (2d) By persons. (3d) First ordinary ; second good. (4th) There is a system of sewerage which traverses the town ; night-soil removed by night ; no public cleaning. (5th) Springs, reservoirs, and wells ; all good. (6th) No. (7th) Good ; siliceous ; no marshes or fevers. (8th) The new at 1,200 meters. (9th) There is none. (10th) Those of 1834 and 1855 were greater ; that of 1865 less than this. (11th) No river nor streams ; only a canal with rapidly running current. (12th) Only observed with respect to the canal. (13th) Railroads, highways and neighboring roads. (14th) Lazarettos and disinfectants. (15th) No. (16th) In the canals, in basins, and in pools at the gates. (17th) 47 days—ascend, 15 ; apogee, 17 ; descent, 15. (18th) Yes ; evidently. (19th) Yes. (20th) 1,327 attacks—534 males, 793 females. (21st) 736 deaths—294 males, 442 females. (22d) In the lower, 485 ; in the upper, 482 ; to the north, 774 ; to the south, 603. (23d) 10 per cent. of the attacks and 2 per cent. of the deaths in the garrison, as compared with those of the town. (24th) Great development with southeast wind, and descent with north wind.

*Tarazona, 4,443 inhabitants.*—(1st answer.) From the 20th of July to the 7th of September. (2d) By persons coming from infected point. (3d) First good ; second ordinary. (4th) Everything wanting concerning this question. (5th) Well-water, of origin unknown ; good ; containing lime. (6th) No. (7th) Clay ; no marshes nor fevers. (8th) At 150 meters. (9th) Nothing. (10th) Those of 1834 and 1855 same as this ; that of 1865 had cases only in three families. (11th) At 160 meters from a stream, and at 10 meters from the Júcar. (12th) Equally. (13th) Neighboring roads. (14th) All with little rigor. (15th) No. (16th) In the stream, in canals, and in pools at the gates. (17th) 49 days—ascend, 19 ; apogee, 10 ; descent, 20. (18th) Yes. (19th) Yes. (20th) 505 attacks—210 males, 295 females. (21st) 187 deaths—72 males, 115 females. (22d) All in the lower. (23d) No attack among the civil guard.

*La Gineta, 2,293 inhabitants.*—(1st answer.) From the 22d of July to the 11th of October. (2d) By persons. (3d) First ordinary ; second bad. (4th) From wells whose origin is unknown ; good, slightly saline. (6th) No. (7th) Good ; clay and sand ; there are no marshes nor frequent fevers. (8th) At 1 kilometer. (10th) Equally. (13th) Railways and neighboring roads. (14th) Disinfectants. (15th) Yes. (16th) In the river and pools. (17th) 51 days ; irregular march. (19th) Yes. (20th) 95 attacks—43 males, 52 females. (21st) 49 deaths—19 males, 30 females. (22d) All in the lower ; equally to north and south. (24th) Many deaths in the typhoid stage.

*La Raneja, 856 inhabitants.*—(1st answer.) From the 23d of July to the 7th of September. (2d) Imported. (3d) Ordinary. (4th) There is none ; household sewage to the river Júcar ; no public cleaning. (5th) Good, potable well-water, containing magnesia. (6th) Unknown. (7th) Sandy ; no marshes ; few intermittent fevers. (8th) At 300 meters. (9th) There is none.



(10th) This time more. (11th) Upon the Júcar. (12th) The part near the river had one-third of the epidemic. (13th) By land. (14th) Isolation in the families of the attacked. (15th) General abuse of peaches. (16th) In the river. (17th) 45 days—ascend, 20; apogee, 5; descent, 20. (18th) Remains stationary during the rains. (19th) Yes. (20th) 51 attacks. (21st) 16 deaths—7 males, 9 females. (22d) All in the lower; only two to the north; the rest to the south.

*Madrigueras, 2,556 inhabitants.*—(1st answer.) From the 23d of July to the 20th of September. (2d) Imported. (3d) First ordinary; second good. (4th) There is none; cleaning by the municipality. (5th) Springs and rain-water; good. (6th) No. (7th) Sandy; malarial fever unknown. (8th) At 600 meters. (9th) Of brick and iron. (10th) In 1834 mild; in 1855 more than this time. (11th) Situated upon a plain. (13th) By land. (14th) All three. (15th) No abuse of fruits during the epidemic. (16th) In the house. (17th) 59 days—ascend, 18; apogee, 12; descent, 29. (18th) The ascent coincided with storms. (19th) Nothing special. (20th) 482 attacks. (21st) 202 deaths. (22d) All in the lower, as there are no upper.

*Mahora, 1,653 inhabitants.*—(1st answer.) From the 24th of July to the 1st of September. (2d) Unknown; the first case outside of the village, and near an infected place. (3d) First bad; second worse. (4th) There is none; public cleaning wanting. (5th) From a deep well, whose origin is unknown; bad; hard and cloudy. (6th) No; but the washing was done in pools after having washed in them clothing from cholera cases. (7th) Sand, clay, and limestone; five pools outside of the village; fevers rare. (8th) At 200 meters; only iron. (10th) In 1834 little; in 1855 great; none in 1865. (11th) At 6 kilometers from the Júcar. (13th) Neighboring roads and highways. (14th) Cordons and lazarettos. (15th) Yes. (16th) The poor washed in the pools; the others in their houses. (17th) 40 days—ascend, 8; apogee, 19; descent, 13. (18th) No. (19th) Yes. (20th) 149 attacks—74 males, 65 females. (21st) 82 deaths—33 males, 49 females. (22d) All in the lower; equally as regards winds. (23d) 6 invasions and no deaths among the civil guards.

*Elche de la Sierra, 3,397 inhabitants.*—(1st answer.) From the 25th of July to the 25th of September. (2d) Imported by persons. (3d) Both bad. (4th) There is none; everything wanting. (5th) Hard and saline spring water. (6th) No. (7th) Granite and clay; irrigated lands; no marshes; there are fevers in summer. (8th) At 200 meters. (9th) Of brick. (10th) That of 1855 was short; that of 1865 only 3 cases. (11th) A stream surrounds a part of the village; in the summer the water falls and leaves the bed dry. (12th) The first cases and half the epidemic was in the part near the river. (13th) Highways. (14th) Cordons and disinfectants. (15th) Yes. (16th) In the streams which supplied water for irrigation; the clothing of the cholera patients was washed at a considerable distance. (17th) 62 days; irregular march. (18th) After a slight storm the epidemic ceased for 4 days. (19th) No. (20th) 44 attacks—20 males, 24 females. (21st) 11 deaths—7 males, 4 females. (22d) All in the lower. (23d) There are none.

*Oya Gonzalo, 1,414 inhabitants.*—(1st answer.) From the 20th of July to the 8th of September. (2d) Imported by persons. (3d) Both bad. (4th) There is none; public cleaning wanting; the rains remove the filth. (5th) From shallow wells containing magnesia. (6th) Surrounded by three wells, from which the drawing of water was prohibited, but this prohibition not obeyed. (7th) Sandy and clayey; considerable surface water and moisture; fevers frequent; more in summer. (8th) At 200 meters. (9th) There is none. (10th) In 1865 there was no epidemic. (11th) Located in a hollow, surrounded by hills. (12th) The lowest part by 90 per cent. (13th) Neighboring roads. (14th) All. (15th) Yes. (16th) Of all ways; the poor in pools because it costs nothing. (17th) 50 days—ascend, 12; apogee, 3; descent, 35. (18th) Yes. (19th) Yes. (20th) Three-fourths of the population. (21st) 185 deaths—adults, 50 per cent.; children, 40 per cent.; aged, 10 per cent. (22d) All in the lower. (23d) Among the civil guards, 3 attacks and 1 death.

*Motilleja, 759 inhabitants.*—(1st answer.) From the 29th of July to the 29th of August. (2d) Unknown. (3d) The second bad. (4th) There is none; the village is elevated and readily washed by rain water. (5th) From the Júcar; during the epidemic they used fountain water near the river. (6th) No. (7th) Good; clayey; no marshes; fevers in autumn. (8th)

At 300 meters. (9th) There is none. (10th) The former more. (11th) The rivers are at 2,000 meters from the village. (12th) Equally. (13th) By land. (14th) Cordons at the beginning. (15th) No. (16th) In the Júcar, and fountains coming from it. (17th) 31 days—ascend, 10; course regular. (18th) No. (19th) Yes. (20th) 82 attacks—41 males, 41 females. (21st) 27 deaths—10 males, 17 females. (22d) All in the lower. (23d) There is none. (24th) The disease is supposed to have originated from a pool at 500 meters distance.

*Abengibre, 862 inhabitants.*—(1st answer.) From the 1st to the 24th of August. (2d) By soiled clothing. (3d) Much is to be desired. (4th) There is none; no cleaning. (5th) Good spring water from a rock. (7th) Granite; fevers rare. (8th) At 400 meters. (9th) There is none. (10th) In 1855 more. (11th) No rivers nor streams in the neighborhood. (13th) Neighboring roads. (14th) Cordons and lazarettos before the epidemic, and afterwards disinfectants. (15th) Very frequent abuse. (16th) In public lavatories; customary to wash outside of the house. (17th) 24 days—ascend, 7; apogee, 8; descent, 9. (18th) No stream. (19th) Yes. (20th) 105 attacks. (21st) 18 deaths—5 males, 13 females. (22d) All in the lower. (24th) In the weak and needy.

*San Pedro, 1,310 inhabitants.*—(1st answer.) From the 4th of August to the 6th of September. (2d) Imported by persons. (3d) The first ordinary; second bad. (4th) No sewerage; the inhabitants clean. (5th) River, well, and spring water; good. (6th) No. (7th) Granite; the river flows through the middle of the town; no marshes; few fevers in autumn. (8th) At 30 meters. (9th) There is none. (10th) More in the former. (11th) On the banks of the river. (12th) Equally. (13th) By land. (14th) All. (15th) No. (16th) In the public lavatory. (17th) 62 days—apogee short. (18th) No. (19th) No. (20th) The whole village. (21st) 13 deaths—3 children, 6 adults, 4 aged. (22d) Equally. (23d) There is none.

*Golosalvo, 217 inhabitants.*—(1st answer.) From the 4th to the 30th of August. (2d) Imported by persons. (3d) Both bad. (4th) There is none; cleaning by the inhabitants. (5th) Well water; good. (6th) No. (7th) Loose rocks; there is a pool and there are no fevers. (8th) At 62 meters. (9th) There is none. (10th) Less than this. (11th) There is no river. (12th) Equally. (13th) Neighboring roads. (14th) All. (15th) No. (16th) In a pool. (17th) 26 days. (18th) No. (19th) Yes. (20th) 61 attacks—6 males, 55 females. (21st) 48 deaths—of all ages. (22d) All in the lower. (23d) There is none.

*Pozuelo, 1,701 inhabitants.*—(1st answer.) From the 8th of August to the 13th of September. (2d) Unknown. (3d) Both bad. (4th) There is none; cleaning by the municipality. (5th) Well water; source unknown; hard, and containing lime. (6th) No. (7th) Clay; no marshes; few fevers. (8th) At a convenient distance; the new is being constructed. (9th) There is none. (10th) More than this time. (11th) Considerable distance from the nearest river. (12th) Equally. (13th) Neighboring roads. (14th) All. (15th) No. (16th) In streams and in the river. (17th) 37 days—ascend, 5; apogee, 10; descent, 22. (18th) No. (19th) No. (20th) 108 attacks—55 males, 53 females. (21st) 26 deaths—12 males, 14 females. (22d) All in the lower. (23d) There is none.

*Montealegre, 2,928 inhabitants.*—(1st answer.) From the 9th to the 29th of August. (2d) Imported by persons. (3d) Both bad. (4th) There is none; cleaning by inhabitants. (5th) Good well water. (6th) No. (7th) Clay; no marshes; few fevers. (8th) At 500 meters. (9th) There is none. (10th) In 1865; none. (11th) No rivers or streams. (13th) Neighboring roads. (14th) Disinfectants. (15th) No. (16th) in a public lavatory, at a distance of 160 meters from the town. (17th) 21 days—ascend, 8; apogee, 4; descent, 9. (18th) No. (19th) Yes. (20th) 104 attacks—32 males, 72 females. (21st) 52 deaths—10 males, 42 females. (22d) All in the lower. (23d) There is none.

*Viveros, 1,302 inhabitants.*—(1st answer.) From the 12th to the 30th of August. (2d) It is suspected by effects from Cartagena. (3d) First good; second bad. (4th) There is none; cleaning by the inhabitants. (5th) From a spring and a well; good. (6th) No. (7th) Calcareous; no marshes nor fevers. (8th) The old in the village; the new at 800 meters. (9th) Of brick. (10th) Never suffered before. (11th) There is no river. (13th) Neighboring roads. (14th) Disinfectants. (15th) No. (16th) In the public lavatory. (17th) 18 days—ascend, 8;



apogee, 3; descent, 7. (18th) No. (19th) Yes. (20th) 41 attacks—18 males, 23 females. (21st) 21 deaths—6 males, 15 females. (22d) All in the lower. (23d) There are none.

*Balazote, 1,577 inhabitants.*—(1st answer.) From the 14th of August to the 12th of October. (2d) By drinking water from the river San Pedro, which comes from Pozuelo, an infected village. (3d) Excessive neglect of all manner of cleanliness; both bad. (4th) There is none; cleaning by the inhabitants. (5th) Used only water from the river Balazote; there are wells for domestic uses. (6th) No. (7th) Rocky, granitic, and clayey; no marshes; at a certain season of the year there is malaria. (8th) At 1 kilometer. (9th) There is none. (11th) The village is surrounded by the river Balazote, an affluent of the San Pedro. (12th) Fifty per cent. more in the part near the river. (13th) By river and by land. (14th) Cordons, lazarettos, and disinfectants. (15th) Yes. (16th) In the river. (17th) 57 days—irregular course. (18) Can not answer categorically. (19th) No. (20th) 143 attacks—63 males, 80 females. (21st) 43 deaths—23 males, 20 females. (22d) All in the lower. (23d) No cases among the civil guard.

*Casas de Ves, 1,867 inhabitants.*—(1st answer.) From the 16th of August to the 7th of September. (2d) By a person. (3d) The first good; second bad. (4th) There is none; cleaning by the inhabitants. (5th) Well and fountain water. (6th) No. (7th) calcareous; there is a glen in which there is abundant water; fevers in autumn. (8th) At 600 meters. (9th) There is none. (10th) Those of 1834 and 1855 were benign. (11th) There is no river. (13th) By land. (14th) Cordons and lazarettos; disinfectants with good results. (15th) No. (16th) In the public lavatory. (17th) 23 days—ascend, 10; apogee, 6; descent 7. (18th) No. (19th) Yes. (20th) 80 attacks—35 males, 45 females. (21st) 24 deaths—6 men, 13 women, 5 children. (22d) All in the lower; to the north, 26; to the south, 54. (23d) In the post of the civil guard there was one of the first cases; they used disinfectants, and without vacating the post; no other cases occurred.

*Villarrobledo, 6,322 inhabitants.*—(1st answer.) From the 18th of August to the 15th of October. (2d) By persons from infected places. (3d) The first good; the second bad. (4th) There is none; each inhabitant removes his night soil to the field. (5th) Rain water and well water; very few springs, of unknown sources; good. (6th) No. (7th) Sandy; no marshes nor intermittent fevers. (8th) At 200 meters. (9th) There is none; rivers and wells. (10th) Former more. (11th) No. (13th) Railway. (14th) Disinfectants. (15th) Predominance of cantaloupes and watermelons. (16th) In the house. (17th) 58 days—ascend, 14; apogee 8; descent, 36. (18th) No coincidence with rains. (19th) Yes. (20th) 229 attacks—112 males, 117 females. (21st) 101 deaths—57 males, 44 females. (22d) All in the lower. (23d) There are none.

#### PROVINCE OF ZARAGOZA.

*Zaragoza, 84,575 inhabitants.*—(1st answer.) From the 23d of June to the 14th of September. (2d) Imported by persons from the province of Valencia, and other infected places. (3d) General conditions very bad, especially in poor quarters; narrow and dirty streets. (4th) There is none; household sewage goes into the sinks in the houses. The hygiene of the city is miserable. (5th) In large part from the river; also from a spring; the latter scarce. (6th) Yes. (7th) Modern alluvium; the subsoil of a large part is of a clayey marl; malarial fevers frequent. (8th) At 3 kilometers, upon a small hill. (9th) Of iron. (10th) Suffered most this time. (11th) Surrounded by three rivers and a canal whose waters contain much organic matter. (12th) Equally, except that Santa Cruz street, in the center, of a square near the Ebro, remained uninvaded. (13th) Railway and roads. (14th) Disinfectants and hygienic measures all incomplete. (15th) Yes. (16th) In the river Ebro and some public lavatories. (17th) 83 days—ascend, 43; apogee, 17; descent, 23. (20th) 5,000 attacks. (21st) 1,559 deaths. (22d) All equal. (23d) In the prisons and convents the attacks were few; the troops were encamped beyond the walls. (24th) Converted into a loathsome mire. The exterior wards, in which the laborers lived, consisted of dirty houses in which every principle of hygiene was unknown.

*Luceni, 621 inhabitants.*—(1st answer.) From the 2d of June to the 2d of September. (2d) Unknown. (3d) Good. (4th) There is none; no cleaning by the municipality. (5th) Good; from the river and canal. (7th) Sand and clay; no marshes; there are intermittent fevers. (8th) At 1 kilometer. (9th) There is none. (10th) The deaths were equal; the attacks were more numerous during this epidemic. (11th) At 2 kilometers from the river and canal. (12th) Equally. (13th) Railway and highways. (14th) Disinfectants. (15th) Yes. (16th) In the stream, river and fountains; washing also in the house. (17th) 92 days. (18th) No. (19th) Yes. (20th) 64 attacks. (21st) 10 deaths—4 males, 6 females. (22d) More to the south. (23d) There are none.

*Urrea de Jalón, 782 inhabitants.*—(1st answer.) From the 15th of June to the 15th of September. (2d) There are none. (3d) Both ordinary. (4th) There is none; cleaning by the inhabitants. (5th) Water from the river Júcar and river Jalón. (6th) No. (7th) Clay and rock; no marshes; pools along the Jalón; intermittent fevers frequent. (8th) At more than 1 kilometer. (9th) There is none. (10th) Equally, benign. (11th) Upon a canal near the Jalón. (12th) Nothing observed. (13th) Railway and highway. (14th) Disinfectants. (15th) Yes. (16th) In the house, in the stream, and in the Jalón. (17th) 92 days—ascend and apogee 45; descent, 47. (18th) Yes. (19th) Yes. (20th) 108 attacks—47 males, 61 females. (21st) 11 deaths—8 males, 3 females. (22d) All in the upper; to the north, 40; to south, 68.

*Morés, 1,298 inhabitants.*—(1st answer.) From the 14th of June to the 11th of September. (2d) Imported by persons. (3d) Both bad. (4th) There is none; cleaning by the municipality. (5th) Spring water and that from the river Jalón. (6th) Abstained from the use of the Jalón water. (7th) Clay; tendency to fevers. (8th) According to law. (9th) Of brick. (10th) This time less. (11th) At 100 meters from the Jalón; surrounded by canals. (12th) Equally. (13th) Rail and highway. (14th) Disinfectants. (15th) No. (16th) In a canal proceeding from the Jalón. (17th) 89 days—ascend, 33; apogee, 17; descent, 39. (18th) Yes. (19th) Yes. (20th) 60 attacks—17 males, 43 females. (21st) 18 deaths—9 males, 9 females. (22d) In the lower, 38; in the upper, 32; to the north, 16; to the south, 44. (23d) There are none.

*Alpartir, 811 inhabitants.*—(1st answer.) From the 28th of June to the 2d of September. (2d) Unknown. (3d) Both bad. (4th) There is none; cleaning by the inhabitants. (5th) Fountain and river water; good. (6th) No. (7th) Ordinary; rocky soil; no marshes nor fevers. (8th) At 500 meters. (9th) There is none. (10th) The former less. (11th) Upon the side of a mountain and a gully. (12th) Equally. (13th) Highways. (14th) General cleanliness. (15th) No. (16th) Generally in the house; also in the water in the gully. (17th) 67 days—ascend, 19; apogee, 8; descent, 40. (18th) Not observed; there were storms and rains. (19th) Unknown. (20th) 139 attacks—55 males, 84 females. (21st) 45 deaths—16 males, 29 females. (22d) All in the upper. (23d) There are none.

*Miércoles, 1,143 inhabitants.*—(1st answer.) From the 21st of June to the 21st of August. (2d) Imported by persons. (3d) The first, ordinary; the second, bad. (4th) Brick sewers; cleaning by the inhabitants. (5th) Good springs. (6th) No. (7th) Clay and limestone; there are reservoirs of spring water; no intermittent fevers. (8th) At 2 kilometers. (9th) Upon a small river. (12th) Equally. (13th) Highways. (14th) Nothing. (15th) Little. (16th) In the public lavatories. (17th) 62 days—ascend, 15; apogee, 5; descent, 42. (18th) Yes. (19th) Yes. (20th) 169 attacks—79 males, 90 females. (21st) 64 deaths—34 males, 30 females. (22d) All in the lower and to the north. (24th) Attributed to much dampness and absence of removal of the excrement of the cholera patients.

*Villanueva del Gallego, 1,263 inhabitants.*—(1st answer.) From the 24th of June to the 28th of August. (2d) Imported by persons. (3d) First, good; second, better. (4th) Nothing. (5th) Water from the canal of the river Gallego. (6th) Nothing. (7th) Clay and limestone; no marshes; fevers frequent in autumn. (8th) At 1 kilometer. (9th) There is none. (10th) The former less than this. (11th) At 1 kilometer from the river. (12th) Greater in the part far from the river. (13th) Railway and highway. (14th) Disinfectants and hygienic measures. (15th) Yes. (16th) In canals; usually in the house. (17th) 65 days. (18th) Yes. The difference was observed during the time of the storm. (19th) Yes. (20th) 157 attacks—76



males, 81 females. (21st) 45 deaths—25 males, 20 females. (22d) Equally in the lower. (23d) Among the civil guard 3 deaths.

*Ricla*, 833 *inhabitants*.—(1st answer.) From the 23d of June to the 11th of September. (2d) Brought by the water of the river Jalón. (3d) First, bad; second, miserable. (4th) There is none; cleaning by the inhabitants. (5th) Water from the river Jalón used for irrigation; bad for drinking. (6th) Yes; of the Jalón water. (7th) Sandy and calcareous; no marshes; intermittent fevers infrequent. (8th) At 1,200 metres. (9th) There is none; irrigation canals. (10th) This time more. (11th) Upon the Jalón. (12th) The part next to river less. (13th) Railway and highways. (14th) Disinfectants. (15th) Yes. (16th) In the river and in a little stream from a spring. (17th) 80 days—ascend, 6; apogee, 19; descent, 55. (18th) The attacks coincided, but not the deaths. (19th) No. (20th) 413 attacks—115 males, 126 females; 172 children. (21st) 151 deaths—56 men, 46 women, 49 children. (22d) Not observed. (23d) There are none. (24th) If the water was the cause of the cholera, how was the village not invaded from the first? All drank it.

*Torres de Berrellén*, 1,089 *inhabitants*.—(1st answer.) From the 25th of June to the 17th of August. (2d) By harvesters from Valencia, and also by communication with the Jalón, which flowed by infected places. (3d) First, bad; second, miserable. (4th) There is none; inhabitants clean; the night soil collects in the public streets and in the court-yards. (5th) Bad; from the river Jalón and some from the river Ebro, containing much organic matter, although agreeable to the palate. (6th) Yes. (7th) Clay; surrounded by marshes; intermittent fevers during the whole year. (8th) At 300 meters; bad hygienic conditions. (9th) There is none. (10th) This time worse. (11th) At the confluence of two rivers, the Jalón and the Imperial Canal. (12th) The upper part 24 attacks and the lower part 22. (13th) Railways and neighboring highways. (14th) Disinfectants. (15th) Considerable during the epidemic. (16th) In the river Jalón, at its union with the Ebro; in canals from the Jalón. (17th) 53 days—ascend, 10; apogee, 20; descent, 23. (18th) Yes, very evidently, in attacks as well as deaths. (19th) Yes. (20th) 76 attacks—37 males, 39 females. (21st) 33 deaths—23 males, 10 females. (22d) 42 in the lower, 34 in the upper; to the south 30, to the north 46.

*Salillas del Jalón*, 315 *inhabitants*.—(1st answer.) From the 25th of June to the 3d of September. (2d) Unknown. (3d) Good. (4th) There is none; cleaning by the inhabitants. (5th) Good; from the Jalón and a spring. (6th) Used Jalón water. (7th) Sand and clay; intermittent fevers frequent in autumn; there is a meadow in which the water collects. (8th) At 300 meters. (9th) Of brick. (10th) Less. (11th) Upon the Jalón, at 1 kilometer. (12th) Equally. (13th) Railways and highways. (14th) Disinfectants. (15th) Yes. (16th) In public lavatories; washing also in the house. (17th) 70 days—ascend, 2; apogee, 4; descent, 64. (18th) Yes; the epidemic developed instantaneously on the day of a storm, with the greatest number of deaths. (19th) Yes. (20th) 54 attacks—21 males, 33 females. (21st) 21 deaths—8 males, 13 females. (22d) More deaths to the north than to the south. (23d) There is none.

*Bardallar*, 724 *inhabitants*.—(1st answer.) From the 25th of June to the 3d of August. (2d) Unknown. (3d) Both bad. (4th) There is none; cleaning by contract and by the inhabitants. (5th) Good; from the Jalón. (6th) Every one uses the Jalón water. (7th) Calcareous and rocky; no marshes nor intermittent fevers. (8th) At 2 kilometers. (9th) There is none. (10th) Less. (11th) Upon a rock on the side of a mountain. (12th) The village is located on dry land. (13th) Railways and neighboring highways. (14th) Disinfectants and isolation. (15th) Yes. (16th) In the house; the clothing of the cholera patients is boiled before washing. (17th) 39 days—ascend, 13; apogee, 8; descent, 18. (18th) Yes. (19th) Yes. (20th) 34 attacks—14 males, 20 females. (21st) 16 deaths—6 males, 10 females. (22d) Unknown. (23d) There are none.

*Utebo*, 1,119 *inhabitants*.—(1st answer.) From the 26th of June to the 1st of September. (2d) Imported by persons. (3d) Both good. (4th) There is none; cleaning by the inhabitants. (5th) Spring and river water; good. (6th) No. (7th) Good; sandy; there are marshes; fevers every year; this year none on account of the drying of the marshes. (8th) At 500 meters; in an elevated location. (9th) There is none. (10th) The present less grave. (11th) To the right of the Ebro. (12th) Equally; the river is at 2 kilometers distance. (13th) Railways

and neighboring roads. (14th) Nothing. (15th) Yes; much. (16th) In canals. (17th) 67 days—ascend, 3; apogee, 3; descent, 61. (18th) No. (19th) No. (20th) 49 attacks—21 males, 28 females. (21st) 28 deaths—12 males, 16 females. (22d) In the upper 20; in the lower 29; to the north 16; to the south 33. (23d) There are none.

*Maluenda*, 1,204 inhabitants.—(1st answer) From the 27th of June to the 8th of September. (2d) Unknown. (3d) first good; second bad. (4th) There is none; household filth thrown into the court-yards; cleaning by the municipality. (5th) Good water from the river Giloca. (6th) No. (7th) Clayey and rocky; no marshes nor intermittent fevers. (8th) At one kilometer. (9th) There is none. (10th) Equally. (11th) On the banks of the Giloca. (12th) Equally. (13th) Railway and neighboring roads. (14th) Some disinfectants. (15th) Yes. (16th) During the epidemic in a conduit for dirty water. (17th) 73 days—in 2 apogees; ascent, 32; descent, 39. (18th) Yes. (19th) No. (21st) 48 attacks—21 men, 18 women, 9 children. (22d) Equally. (23d) There are none; one death in a convent. (24th) After correction of the vomiting and diarrhoea the typhoid state and death supervened.

*Morata de Jalón*, 1,943 inhabitants.—(1st answer.) From the 26th of June to the 23d of August. (2d) Imported by persons. (3d) First good; second bad. (4th) There is none; cleaning by the inhabitants. (5th) Jalón water and various springs, containing lime, magnesia, and soda. (6th) No. (7th) Clay, sand, limestone; no marshes nor intermittent fevers. (8th) At 800 meters. (9th) There is none. (10th) All the former together did not equal half the deaths of the last. (11th) At 1,000 meters from the Jalón. (12th) Suffered most in the center. (13th) Railway and neighboring highways. (14th) Cleanliness and disinfection. (15th) Abstained during the epidemic. (16th) Washing in the houses or in running water. (17th) 58 days—ascend, 24; apogee, 13; descent, 21. (18th) Yes; evidently. (19th) No. (20th) 370 attacks—133 males, 237 females. (21st) 126 deaths—50 males, 76 females. (22d) No data. (23d) There are none. (24th) Attributed to want of hygiene.

*Almonacid de la Sierra*, 2,151 inhabitants —(1st answer.) From the 28th of June to the 4th of September. (2d) By a person having drank water from the river Jalón contaminated by infected villages. (3d) First bad; second miserable. (4th) There is none; cleaning by whoever pleases. (5th) From a mountain spring. (6th) Yes. (7th) Granite and clay; no marshes nor intermittent fevers. (8th) At 300 meters. (9th) Of brick. (10th) That of 1855 greater. (11th) The village surrounded by several gullies. (12th) Equally. (13th) Neighboring roads. (14th) Disinfectants. (15th) Yes. (16th) In the public lavatory. (17th) 68 days—ascend, 22; apogee, 7; descent, 39. (18th) Yes; the mortality and number of attacks increased within 24 hours. (19th) Yes. (20th) 493 attacks—157 males, 336 females. (21st) 98 deaths—32 males, 66 females. (22d) Unknown. (23d) There are none. (24th) Subsoil moist; population crowded; bad hygienical conditions, these were the principal factors in the development of the epidemic.

*Villafeliche*, 1,348 inhabitants.—(1st answer.) From the 28th of June to the 19th of August. (2d) Unknown. (3d) Ordinary. (4th) There is none; night soil is collected in the court-yards; cleaning by the inhabitants. (5th) Good spring water. (6th) Unknown. (7th) Sandy and calcareous; no marshes nor fevers. (8th) At 700 meters. (9th) There is none. (10th) Former more intense. (11th) On the right bank of the Giloca. (12th) Not noted. (13th) Highway. (24th) Disinfectants and fumigations. (15th) No. (16th) In streams. (17) 53 days; slow course. (18th) No. (19th) Unknown. (20th) 64 attacks—22 males, 42 females. (21st) 32 deaths—14 males, 18 females. (22d) Unknown. (23d) There are none.

*Calatayud*, 11,512 inhabitants.—(1st answer.) From the 29th of June to the 22d of September. (2d) By a lady recently arrived from Zaragoza. (3d) House of the first attack was very damp; in the lower part of the village. (4th) There is none; no public cleaning; excrement thrown into the court-yards and sinks. (5th) From the rivers Jalón and Giloca, and from springs; good, containing lime and magnesia. (6th) Very bad attack; without distinction, although having used boiled water and spring water. (7th) Sand and clay; no marshes, and intermittent fevers not very frequent, except among the inhabitants of the surrounding lands, who suffer in the autumn. (8th) At 2,400 meters. (9th) Paved with brick. (10th) Since



1834 constantly decreasing until, in 1865, there were only 6 attacks. (11th) On the bank of the Jalón at 1,000 meters from its confluence with the Giloca. (12th) The mortality was less near the river by 40 per cent. (13th) Railway, highway, and neighboring roads. (14th) Disinfectants. (15th) No. (21th) In public lavatories, in the Jalón; and in the houses, by the classes in easy circumstances. (17th) 84 days—ascend, 33; apogee, 20; descent, 31. (18th) Yes; notably. (19th) No. (20th) 2,509 attacks—1,474 males, 1,035 females. (21st) 818 deaths—308 males, 510 females. (22d) Can not specify; less to the south. (23d) In the prison no attacks; in the hospital few. (24th) The laboring classes outside the village were much attacked at the beginning. Afterwards the well-to-do classes in the interior of the village suffered; principally pregnant women.

*Pleitas*, 162 inhabitants.—(1st answer.) From the 30th of June to the 8th of August. (2d) Unknown. (3d) Both bad. (4th) There is none; cleaning by the inhabitants. (5th) Water from the Jalón; agreeable. (6th) Yes; the Jalón water and that from the canal supplied by the same. (7th) Sandy and cretaceous; no marshes nor frequent intermittent fevers. (8th) At 30 meters. (9th) There is none. (10th) More this time. (11th) On the Jalón. (12th) Equally. (13th) Highways. (14th) Disinfectants. (15th) Yes. (16th) In the canal called Pedrola, and in the houses. (17th) 39 days; ascent up to the 19th of July; descent afterwards. (18th) No. (19th) No. (20th) 17 attacks—8 males, 9 females. (21st) 11 deaths—7 males, 4 females. (22d) All in the upper. (23d) There are none.

*Ateca*, 5,265 inhabitants.—(1st answer.) From the 2d of July to the 27th of August. (2d) Imported by a wandering beggar. (3d) Both ordinary. (4th) There is none; night soil taken to the rivers and into the court-yards; cleaning by the municipality. (5th) Good spring water, containing magnesia. (6th) Yes; suspected. (7th) Granite and sand; no marshes nor intermittent fevers. (8th) At 800 meters. (9th) Of iron pipes. (10th) Much more in former, on account of preventive measures this time. (11th) At the confluence of the three rivers Jalón, Mambles, and Piedra. (12th) Equally. (13th) Railroads and highways. (14th) Cordons, lazarettos, and disinfectants. (15th) Prohibited. (16th) During the epidemic in lavatories and springs; ordinarily in the river. (17th) 56 days. (18th) Yes. (19th) Yes. (20th) 214 attacks—88 males, 126 females. (21st) 30 deaths—11 males, 19 females. (22d) Majority in the lower and to the south. (23d) In the district prison two attacks; two persons coming from an infected point attacked.

*Escatrón*, 2,595 inhabitants.—(1st answer.) From the 2d of July to the 17th of August. (2d) The first case in an inn; imported. (3d) Both very bad. (4th) There is none; cleaning by the municipality; excrements in the courts. (5th) From the river Ebro. (6th) Yes; Ebro water. (7th) Clay and limestone; no marshes nor intermittent fevers. (8th) At 150 meters. (9th) There is none. (10th) Equally. (11th) At the confluence of the Ebro and Martin. (12th) Equally. (13th) By river and highways. (14th) Disinfectants. (15th) Yes. (16th) In the river. (17th) 46 days—ascend, 15; apogee, 15; descent, 16. (18th) Yes. (19th) Yes. (20th) 400 attacks—250 males, 150 females. (21st) 104 deaths—51 males, 53 females. (22d) Indifferently. (23d) There are none. (24th) At the apogee some fulminant cases.

*Leciñena*, 1,376 inhabitants.—(1st answer.) From the 4th of July to the 2d of September. (2d) Imported by persons and effects. (3d) The first ordinary; the second bad. (4th) There is none; no public cleaning. (5th) Pool water; and when this is wanting, from an irrigation canal proceeding from the river Gallego. (6th) Unknown. (7th) Sandy and calcareous; no marshes nor frequent intermittent fevers. (8th) At 1 kilometer. (9th) There is none. (10th) Yes; more. (11th) No river. (13th) Highways. (14th) Disinfectants and lazarettos. (15th) Excessive. (16th) Private basins and in the houses. (17th) 60 days—ascend, 10; apogee, 12; descent, 38. (18th) Yes. (19th) Yes. (20th) 110 attacks—34 males, 76 females. (21st) 31 deaths—11 males, 20 females. (22d) Lower stories, 90; upper, 20; to the south, 70; to the north, 40.

*Cinco Olivas*, 691 inhabitants.—(1st answer.) From the 5th of July to the 25th of August. (2d) Unknown; supposed by lack of hygiene and by bad food. (3d) Both bad. (4th) There is none; the inhabitants clean as they please. (5th) River water; good in winter; bad in sum-

mer. (6th) Use of Ebro water; unhealthy. (7th) Granite and calcareous; no marshes nor frequent fevers. (8th) At 212 meters. (9th) There is none. (10th) 1,866 less. (11th) Surrounded by the Ebro and the irrigation canal. (12th) Equally. (13th) Neighboring roads connecting with the railroad. (14th) Public cleanings, fumigations, and disinfection. (15th) Much. (16th) In the river, and generally in the houses. (17th) 51 days—ascend, 14; apogee, 12; descent, 25. (18th) No. (19th) Yes. (20th) 84 attacks—56 adults, 7 aged, 21 children. (21st) 16 deaths—8 adults, 2 aged, 6 children. (22d) In the lower, 70; in the upper, 14; to the north, 28; to the south, 56. (24th) The majority inhabited lower stories; bad food.

*Terrer, 1014 inhabitants.*—(1st answer.) From the 1st of July to the 4th of September. (2d) By persons from infected places. (4th) There is none; the inhabitants clean by removing night-soil to the fields. (5th) The river Jalón water; good when it is clear. (6th) No. (7th) It is on the side of the mountain, at 500 meters elevation; no marshes nor frequent fevers. (8th) At 400 meters. (9th) There is none. (10th) In 1834 and 1855 equal to this. (11th) Upon the river. (12th) Equally. (13th) Railroads and highways. (14th) Disinfectants. (15th) Yes. (16th) In the river, and each house for itself. (17th) 65 days—ascend, 9; apogee, 9; descent, 47. (18th) Yes. (19th) No. (20th) 175 attacks—74 males, 101 females. (21st) 70 deaths—25 males, 45 females. (22d) Indifferently. (23d) There are none.

*Pastriz, 580 inhabitants.*—(1st answer.) From the 7th of July to the 31st of the same. (2d) By a female harvester coming from Torres de Zaragoza. (3d) Both fair; much dampness. (4th) There is none; cleaning by the municipality. (5th) From the river Gallego; good. (6th) No. (7th) Clay; surrounded by marshes; intermittent fevers. (8th) At 800 meters. (9th) There is none. (10th) The former less than this. (11th) Between the river Ebro and its canal. (12th) Equally. (13th) General highway from Zaragoza. (14th) Disinfectants. (15th) Yes. (16th) In canals proceeding from Vidau; all the clothing outside of the house. (17th) 26 days; slow course. (18th) Yes; on the same day. (19th) Yes; insignificant. (20th) 59 attacks—28 males, 31 females. (21st) 51 deaths—23 males, 28 females. (22d) All in the upper; equally as respects the points of the compass.

*Padrilla, 662 inhabitants.*—(1st answer.) From the 9th of July to the 27th of August. (2d) Imported by a person. (3d) First bad; second good. (4th) There is none; cleaning by the inhabitants. (5th) Good Ebro water. (6th) No. (7th) Sandy, calcareous; there are distant marshes; fevers not frequent. (8th) At 200 meters. (9th) No. (10th) Of the two former one greater and the other less. (11th) On the Ebro. (12th) Equally. (13th) By land. (14th) Disinfectants. (15th) Yes. (16th) Washing in the Ebro, outside of the house. (17th) 49 days—ascend, 22; apogee, 12; descent, 15. (18th) Epidemic began after a storm. (19th) Yes. (20th) 94 attacks—38 males, 56 females. (21st) 39 deaths. (22d) In the lower, 60; in the upper, 30.

*Zuera, 1977 inhabitants.*—(1st answer.) From the 29th of July to the 21st of September. (2d) Imported by persons. (3d) Both bad. (4th) There is none; cleaning by the inhabitants. (5th) Canals proceeding from the Gallego. (6th) Yes; on account of filth which falls into the canals along the road traversed by carts and horses. (7th) Rocky in part, and also conglomerate; frequent fevers. (8th) At 7 meters. (9th) Iron pipes. (10th) In the former epidemic less than this. (11th) Between the river Gallego and two canals. (12th) Suffered most near the canal. (13th) Railways; highways from Zaragoza. (14th) Disinfectants and hygienic measures. (15th) Generally very frequent; prohibited during the epidemic. (16th) In the river; outside of the house; the public lavatory was closed. (17th) 54 days—ascend, 11; apogee, 18; descent, 25. (18th) Maximum mortality with rain. (19th) Yes. (20th) 269 attacks—133 males, 136 females. (21st) 96 deaths—43 males, 53 females. (22d) Unknown; to the north, 125; to the south, 124. (23d) There are none. (24th) Want of hygiene, and water collected after irrigation, are the causes of frequent intermittent fevers.

*Osera de Ebro, 547 inhabitants.*—(1st answer.) From the 10th of July to the 2d of October. (2d) Unknown. (3d) Both good. (4th) There is none; public cleaning by contract. (5th) Ebro water. (6th) No. (7th) Clay; intermittent fevers in autumn. (8th) At the commencement of the epidemic interment in the town; afterwards at 1 kilometer. (9th) There is none.



(10th) Nearly equal. (11th) On the banks of the Ebro. (12th) Equally. (13th) Highway and neighboring roads. (14th) Disinfectants. (15th) Much. (16th) After the rinsing in the house, washing in the river Ebro. (17th) 83 days—ascend, 20; apogee, 21; descent, 42. (18th) Yes; 3 days afterwards. (19th) Yes. (20th) 80 attacks—50 males, 30 females. (21st) 26 deaths—12 males, 14 females. (22d) Unknown. (23d) There are none.

*Malpica, 259 inhabitants.*—(1st answer.) From the 27th of July to the 20th of August. (2d) By persons. (3d) Both good. (4th) There is none; cleaning by the inhabitants. (5th) Very good fountains; besides from the river Alba, at 1 kilometer distance. (6th) No. (7th) Calcareous; no marshes nor frequent fevers. (8th) At 1,500 meters. (9th) There is none; there exists a stone reservoir of 15 meters breadth and 2 meters depth. (10th) All the former were less. (11th) At 1 kilometer from a small river. (12th) Equally. (13th) By land. (14th) Disinfectants and isolation. (15th) No. (16th) In the river. (17th) 26 days—ascend, 11; descent, 15. (18th) Yes; rapidly causing ascend and fulminant cases. (19th) Yes. (20th) 44 attacks—10 children, 18 men, 16 women. (21st) 11 deaths—3 children, 6 men, 2 women. (22d) Not observed. (23d) There are none.

*Orcajo, 455 inhabitants.*—(1st answer.) From the 11th of July to the 8th of September. (2d) Imported by effects. (3d) First good; second miserable; near a pool. (4th) There is none; no public cleaning. (5th) Good; spring water. (6th) No. (7th) Sandy; calcareous; there is a pool near the village; no fevers. (8th) At 600 meters. (9th) There is none. (10th) In the former the mortality was greater on account of the miserable conditions. (11th) A river at a great distance. (13th) Highways. (14th) Cordons, disinfectants, and fumigation. (15th) Yes; much. (16th) In streams. (17th) 59 days—ascend, 10; apogee, 20; descent, 29. (18th) Yes; visibly. (19th) There were diarrhoeas and colics before the epidemic. (20th) 120 attacks—52 males, 68 females. (21st) 32 deaths—13 males, 19 females. (22d) Almost all in the lower. (23d) There are none. (24th) Those who observed a careful diet were not affected.

*Cetina, 1,169 inhabitants.*—(1st answer.) From the 12th of July to the 28th of August. (2d) Imported by a harvester from Zaragoza. (3d) First, bad; second, fair. (4th) There is none; cleaning by the inhabitants. (5th) Water from the river Jalón, and from distant springs; during the epidemic the river water was prohibited, but the inhabitants used it furtively. (6th) Suspected. (7th) Clay; no marshes, malarial fever endemic; more frequent in autumn. (8th) At 1 kilometer. (9th) There is none. (10th) 89 deaths in 1834; 81 in 1855. (11th) Elevated; near the Jalón; there are numerous canals. (12th) Equally. (13th) Railway running along the Jalón and highways. (14th) Disinfectants and medical inspection. (15th) Much. (16th) In the house and canals. (17th) 47 days; ascend, 22; apogee, 5; descent, 20. (18th) Yes. (19th) Only during the epidemic. (20th) 218 attacks—95 males, 123 females. (21st) 85 deaths—37 males, 48 females. (22d) Majority in the lower; more to the south than to the north. (23d) There are none.

*Nonaspe, 1,321 inhabitants.*—(1st answer.) From the 12th of July to the 18th of August. (2d) Unknown. (3d) First, good; second, bad. (4th) There is none; the inhabitants charged with public cleaning by the municipality. (5th) From the river Matassana; good, containing magnesia. (6th) The river water believed to be infected. (7th) Sand and clay, with traces of lime; no marshes nor fevers. (8th) At 200 meters. (9th) There is none. (10th) The former a little more. (11th) At the confluence of two rivers. (12th) The part near the cemetery suffered most. (13th) By land. (14th) Sulphur, chloride of lime, and blazing fires. (15th) Yes; abuse of cantaloupes, etc. (16th) Each one in the river. (17th) 36 days—ascend, 14; apogee, 6; descent, 16. (18th) Yes. (20th) 112 attacks—35 males, 77 females. (21st) 26 deaths—12 males, 14 females. (22d) In the lower, 18; in the upper, 115; to the north, 94; to the south, 36.

*Villarroya de la Sierra, 2,145 inhabitants.*—(1st answer.) From the 13th of July to the 31st of August. (2d) The first case was a laborer who had no communication with cholera patients; he drank water of a fountain not fit for drinking, and died in three hours and a half. (3d) The first, good; the second, bad and damp. (4th) There is none; cleaning by the municipality. (5th) Very good spring water, but badly introduced, passing through court-yards and

other filthy places. (6th) Suspected from the use of contaminated water. (7th) Calcareous and clayey; no marshes nor frequent fevers. (8th) At 1,500 meters. (9th) Of brick; in bad condition. (10th) The former more intense. (11th) Upon a stream or pool in which water collects. (12th) Equally. (13th) Highways and neighboring roads. (14th) All. (15th) Yes. (16th) In the stream and in the house. (17th) 49 days; very irregular in its course. (18th) Yes. (19th) No. (20th) 533 attacks; the majority in adults and women. (21st) 144 deaths—38 males, 106 females. (22d) Without distinction. (23d) The civil guard suffered equally with the inhabitants.

*Bordalba, 650 inhabitants.*—(1st answer.) From the 14th of July to the 13th of September. (2d) Imported by a person from an infected place. (3d) Both good. (4th) There is none; cleaning by the inhabitants under direction of the municipality. (5th) Rain and fountain water; excellent. (6th) No. (7th) Calcareous and clayey; to the north a pool, and another to the west. (8th) At 400 meters. (9th) There is none. (10th) This time more. (11th) Near the river. (12th) Equally. (13th) Highways. (14th) Public cleaning, hygiene and disinfectants. (15th) No. (16th) Washing in the house. (17th) 60 days—ascend, 15; apogee, 9; descent, 36. (18th) No. (19th) Yes. (20th) 152 attacks—56 males; 96 females. (21st) 35 deaths—15 males; 20 females. (22d) In the lower, 52; in the upper, 93; to the north, 70; to the south, 112.

*Lecera, 1,765 inhabitants.*—(1st answer.) From the 15th of July to the 4th of September. (2d) Supposed by an inhabitant who transports fruit. (3d) First, good; second, ordinary. (4th) There is none; excrement to the fields for manure; the municipality cleans. (5th) Spring water, containing alum and sulphate of alumina; good. (6th) No. Calcareous and clay; no marshes nor fevers. (8th) At more than 1 kilometer. (9th) There is none. (10th) Anterior more intense. (11th) On a dry plain. (13th) Highways and neighboring roads. (14th) All. (15th) No fruits nor vegetables produced. (16th) In the public lavatory, supplied by the overflow of a spring. (17th) 50 days—ascend, 20; apogee, 10; descent, 20. (18th) Yes. (19th) Yes. (20th) Attacks, about 300. (21st) 47 deaths—24 males, 23 females. (22d) Without distinction. (23d) There are none. (24th) Cordons thought useless.

NOTE.—In the village of Grisen, of 365 inhabitants, and very bad hygienic conditions, situated upon the banks of the Jalón, and using this water for drinking, the epidemic did not develop, in spite of being surrounded by infected villages.

*Cadrete, 665 inhabitants.*—(1st answer.) From the 15th of July to the 27th of August. (2d) Contact with persons proceeding from infected persons. (3d) Both good. (4th) There is none; cleaning by the inhabitants. (5th) From the river Huerva, or from the Imperial canal, Aragon. (6th) No. (7th) Rocky; intermittents rare. (8th) At 1½ kilometers. (9th) There is none. (10th) This time less. (11th) Upon the river Huerva. (12th) Equally. (13th) By land. (14th) Disinfectants. (15th) Yes. (18th) In running water. (19th) Yes. (20th) 180 attacks—70 males, 110 females. (21st) 48 deaths. (22d) Unknown.

*Mequinenza, 2,677 inhabitants.*—(1st answer.) From the 15th of July to the 31st of August. (2d) Imported by persons. (3d) First, good; second, ordinary. (4th) There is none; cleaning by the inhabitants. (5th) From the Ebro and the Segre; the latter better. (6th) No. (7th) Sand and clay; no marshes, and fevers not frequent. (8th) At 1 kilometer. (9th) There is none. (10th) That of 1854 greater. (11th) Upon the two rivers, Ebro and Segre. (12th) Equally. (13th) By river and highways. (14th) The preventive measures consisted in prohibiting entrance without a certificate of health. (15th) Yes. (16th) In the rivers. (17th) 47 days—ascend, 20; apogee, 10; descent 17. (18th) Yes; the development coincided. (19th) No. (20th) 156 attacks—95 males, 61 females. (21st) 59 deaths—37 males, 22 females. (22d) Unknown. (23d) There is a castle; one case occurred in it.

*La Vilueña, 377 inhabitants.*—(1st answer.) From the 17th of July to the 9th of September. (2d) Imported by persons. (3d) First, good; second, ordinary. (4th) There is none; cleaning by the municipality. (5th) Good spring water. (6th) No. (7th) Good; granite; only small pools; fevers not frequent. (8th) Near the village. (9th) Of iron. (10th) Former greater. (11th) In the midst of several streams. (12th) Equally. (13th) By land. (14th) All. (15th) No. (16th) In the streams. (17th) 53 days—ascend, 23; apogee, 22; descent, 8. (18th) Yes.



(19th) Yes. (20th) 30 attacks. (21st) 6 deaths—2 males, 2 females, 2 children. (22d) All in the lower and to the south. (23d) There are none. (24th) The patients died rapidly.

*Sestrica*, 939 *inhabitants*.—(1st answer.) From the 17th of July to the 22d of August. (2d) By an inhabitant coming from an infected place. (3d) First, good; second, ordinary. (4th) There is none; the inhabitants remove the night soil by order of the municipality. (5th) Good spring water. (6th) No. (7th) Clay; no marshes nor intermittent fevers. (8th) At 100 metres. (9th) Of brick. (10th) This time less. (11th) A small stream. (12th) Equally. (13th) By rail and roadways. (14th) Lazarettos and disinfectants. (15th) Use of fruits prohibited. (16th) In the streams. (17th) 36 days—ascend, 12; apogee, 10; descent, 14. (18th) Yes. (19th) No. (20th) 99 attacks—35 males, 64 females. (21st) 39 deaths. (22d) Generally in the lower.

*Torralba de los Fràiles*, 443 *inhabitants*.—(1st answer.) From the 17th of July to the 14th of September. (2d) Imported by persons. (3d) First, good; second, bad. (4th) There is none; cleaning by the municipality. (5th) Good spring water. (6th) No. (7th) Clay; no marshes nor frequent fevers. (8th) Adjoining the village. (9th) There is none. (10th) The other time there was no epidemic; thought not to have been imported. (11th) High location. (12th) Ground is very dry. (13th) By land. (14th) Nothing. (15th) There is none. (16th) In private lavatories. (17th) 59 days—ascend, 28; apogee, 13; descent, 18. (18th) No. (19th) Yes. (20th) 81 attacks—29 males 52 females. (21st) 15 deaths—3 males, 12 females. (22d) All in the lower; to the south, 48; to the north, 14; to the east, 13; to the west, 6. (23d) There are none.

*Aniñón*, 1,814 *inhabitants*.—(1st answer.) From the 17th of July to the 31st of August. (2d) Unknown. (3d) First, good; second, the worst in the village. (4th) There is none; cleaning by the inhabitants. (5th) Good spring water. (6th) No. (7th) Calcareous and sandy; no marshes, and intermittent fevers rare. (8th) At 500 meters. (9th) There is none. (10th) The former more severe. (11th) The village surrounded by 2 small streams. (12th) Equally. (13th) By land. (14th) Disinfectants and medical inspection. (15th) Yes. (16th) In the streams. (17th) 46 days—ascend, 14; apogee, 16; descent, 16. (18th) Yes; after a great storm the epidemic developed. (19th) No. (20th) 388 attacks—138 males, 190 females; 30 aged, 30 children. (21st) 89 deaths—33 males, 56 females. (22d) Equally in all. (23d) There are none.

*Muël*, 1,138 *inhabitants*.—(1st answer.) From the 18th of July to the 18th of August. (2d) Imported by persons. (3d) First good and the second better. (4th) There is none; inhabitants clean. (5th) From the river and spring; both good; the river is the Huerva. (6th) No. (7th) Good; sand and clay; no marshes nor frequent fevers. (8th) At more than 1 kilometer. (9th) There is none. (10th) That of 1855 was less, but the village contained less inhabitants. (11th) On the banks of the river Huerva. (12th) Equally. (13th) Highways. (14th) Fumigations and disinfectants. (15th) Yes. (16th) Outside of the house, in running water, or in the river. (17th) 31 days—ascend, 10; apogee, 8; descent, 13. (18th) Yes; cholera appeared 2 days afterwards. (19th) No. (20th) 398 attacks—majority among women and those affected with chronic diseases. (21st) 110 deaths—37 males, 73 females. (22d) All in the upper. (23d) Post of the civil guard affected proportionately.

*Maynar*, 522 *inhabitants*.—(1st answer.) From the 19th of July to the 18th of August. (2d) By persons from infected places. (3d) The first, ordinary; the second, fair. (4th) There is none; cleaning by the municipality. (5th) Good fountain water from a spring. (6th) No. (7th) Sandy, calcareous, and clayey; intermittent fevers unknown. (8th) At 10 meters from the village. (9th) There is none. (10th) In 1865 less. (11th) Near 2 small rivers. (12th) 35 per cent. more. (13th) By land. (14th) Disinfectants. (15th) Yes. (16th) Washing in the houses. (17th) 30 days—ascend, 11; apogee, 9; descent, 10. (18th) Yes. (19th) Yes; a peculiar pain in the stomach. (20th) 132 attacks—43 males, 89 females. (21st) 40 deaths—12 males, 28 females. (22d) In the upper, 110; in the lower, 22; to the north 90; to the south 42. (23d) There are none. (24th) Bad hygienic conditions and bad food were unfavorable influences surrounding the poor.

*Remolinos, 902 inhabitants.*—(1st answer.) From the 20th of July to the 8th of September. (2d) Unknown. (3d) The first, good; the second, bad; in the houses of the poor the animals and men live together, and their excrement accumulates there. (4th) There is none; the inhabitants clean. (5th) Canal water from the Ebro. (6th) No. (7th) Alluvium, gravel and clay; no marshes, and there are intermittent fevers in September, October, May, and June. (8th) One was constructed for the epidemic, at 500 meters from the village; the other was situated at 40. (9th) There is none. (10th) In 1865 no deaths; in the former very few; not known why. (11th) Near the canal Tauste, and not far from the Ebro. (12th) Equally. (13th) Neighboring roads. (14th) Disinfectants. (15th) Yes. (16th) In the canals. (17th) 50 days—ascend, 21; apogee, 12; descent, 17. (18th) Yes; the storm terrified the inhabitants; the cholera developed with fury during the night; the patients died in a few hours. (19th) Yes. (20th) 146 attacks—58 males, 88 females. (21st) 49 deaths—19 males, 30 females. (22d) Equally; majority of the cases to the south. (23d) There are none. (24th) Those attacked who did not die in a few hours were carried off on the 5th day with asthenic fever.

*Lagata, 480 inhabitants.*—(1st answer.) From the 22d of July to the 20th of August. (2d) By persons from infected places. (3d) The first bad, the second worse; much moisture. (4th) There is none; cleaning by the municipality. (5th) Good springs coming from a neighboring gully. (6th) No. (7th) Sand and clay; no marshes, and there are pools; no fevers. (8th) At 800 meters. (9th) There is none. (10th) The former light. (11th) At 900 meters from the river, but near to an irrigating huerta. (12th) Equally. (13th) High roads. (14th) Disinfectants and cleaning. (15th) Prohibited. (16th) In canals and in the river. (17th) 29 days—ascend, 8; apogee, 5; descent, 19; after a cessation the epidemic revived 20 days afterwards. (18th) No. (19th) Yes. (20th) 196 attacks—96 males, 100 females. (21st) 52 deaths—24 males, 28 females. (22d) In the upper, 79; in the lower, 107; to the north, 82; to the south, 91; uncertain to the west, and to the east, 23. (23d) There are none. (24th) A number of attacks after an interval of 20 days' cessation.

*Castiliscar, 842 inhabitants.*—(1st answer.) From the 24th of July to the 4th of September. (2d) Unknown. (3d) All bad. (4th) There is none; the municipality cleans. (5th) From a reservoir supplied by a fountain; removed in casks; it is miserable. (6th) Yes; epidemic attributed to the water. (7th) Sand and clay; no marshes, but there is a large pool adjoining the wells of the village; much intermittent fever in the autumn. (8th) At 700 meters. (9th) There is none. (10th) This time greater. (11th) Near a small stream. (12th) Equally. (13th) By land. (14th) All. (15th) Little. (16th) In the stream. (17th) 42 days—ascend, 8; apogee, 10; descent, 24. (18th) Yes. (19th) No. (20th) 149 attacks. (21st) 81 deaths—27 males, 54 females. (22d) Equally. (23d) There are none.

*Ibdes, 1,114 inhabitants.*—(1st answer.) From the 25th of July to the 17th of September. (2d) Unknown. (3d) First, bad; second, worse; damp. (4th) There is none; the court-yards are infectious; cleaning by the municipality. (5th) Good river water from the Mesa. (6th) No. (7th) Clay; on account of the moist condition of the banks of the river, where there are pools, there is much intermittent fever. (8th) Near the village, and in bad condition. (9th) There is none. (10th) In that of 1855, 300 persons died. (11th) Upon the river Mesa, surrounded by a large canal. (12th) Equally. (13th) Neighboring roads. (14th) All. (15th) Yes. (16th) In the canal. (17th) 54 days—ascend, 6; apogee, 15; descent, 33. (18th) Yes. (19th) Yes. (20th) 495 attacks—198 males, 297 females. (21st) 109 deaths—42 males, 67 females. (22d) Unknown. (23d) There are none. (24th) It is believed by the use of infected water, proceeding from infected places, that the epidemic was caused.

*Tobed, 1,123 inhabitants.*—(1st answer.) From the 25th of July to the 30th of September. (2d) By persons from infected places. (3d) First, good; second, bad. (4th) There is none; night-soil into the court-yards; cleaning by the inhabitants. (5th) Good spring and fountain water. (6th) No. (7th) Sandy; no marshes; rare intermittent fevers. (8th) At 500 meters. (9th) There is none. (10th) This time greater. (11th) At the confluence of the river and the ravine. (12th) Unknown. (13th) By river and land. (14th) All. (15th) Yes. (16th) In the river and in the ravine. (17th) 66 days—ascend, 15; apogee, 30; descent, 21. (18th) Yes.



(19th) Not observed. (20th) 50 attacks—14 males, 36 females. (21st) 46 deaths—16 males, 30 females. (24th) The epidemic did not respect either cleanliness or easy circumstances.

*Bujaraloz*, 2,004 inhabitants.—(1st answer.) From the 26th of July to the 13th of September. (2d) By a person. (3d) All good. (4th) There is none; cleaning by the inhabitants. (5th) Rain-water, collected in reservoirs for the use of the village. (6th) No. (7th) Calcareous; no marshes nor frequent fevers. (8th) At 1,000 meters. (9th) There is none. (11th) Neither rivers nor streams. (13th) Highways. (14th) Disinfectants. (15th) No. (16th) In basins in the house. (17th) 49 days—ascend, 17; apogee, 15; descent, 17. (18th) Yes. (19th) Yes. (20th) 96 attacks—37 males, 59 females. (21st) 40 deaths—13 males, 27 females. (22d) In the lower, 80; in the upper, 19; to the north 56, to the south 40. (23d) There are none. (24th) A tendency to attack pregnant women and convalescents.

*El Frago*, 559 inhabitants.—(1st answer.) From the 27th of July to the 30th of August. (2d) By persons. (3d) Both bad; the first attacks in houses near the river Arba. (4th) There is none; cleaning by the municipality. (5th) Good; from the rivers Arba and Cervera. (6th) No. (7th) Clay and rock; no fevers. (8th) At 1,000 meters, on the top of a hill. (9th) There is none. (10th) In those of 1854 and 1855 only 8 persons died. (11th) Between the rivers Abro and Cervera, at 1,000 meters from each. (12th) Double in the upper, near the river. (13th) Neighboring roads and the river Arba. (14th) All. (15th) No. (16th) In the rivers at a great distance from the village. (17th) 34 days—ascend, 8; apogee, 6; descent, 20. (18th) Yes; a heavy rain caused the river to rise, the waters of which gave off a sulphurous odor, after which the cases began to appear. (19th) Yes. (20th) 89 attacks. (21st) 55 deaths. (22d) In the upper, and to the east and west. (23d) There are none.

*Munébrega*, 1,103 inhabitants.—(1st answer.) From the 28th of July to the 5th of October. (2d) By persons. (3d) The first good; the second miserable. (4th) There is none; night-soil into the court-yards; cleaning by the inhabitants. (5th) Fair spring water. (6th) No. (7th) Sand and clay; no marshes nor fevers; the latter appear in a ward near a spring when the latter contains water. (8th) At 500 meters. (9th) Of brick. (10th) The anterior very severe. (11th) Upon a little stream. (12th) In the part near the stream 70 per cent. more attacked. (13th) Neighboring roads. (14th) Disinfectants and hygiene. (15th) Yes. (16th) In the village, each inhabitant. (17th) 69 days—ascend, 20; apogee, 15; descent, 34. (18th) Yes. (19th) No. (20th) 166 attacks—60 males, 106 females. (21st) 33 deaths—16 males, 17 females. (22d) Equally. (23d) There are none. (24th) The benign character of this epidemic as compared to the former is attributed to the rigid hygienic measures.

*Calmarza*, 367 inhabitants.—(1st answer.) From the 29th of July to the 24th of September. (2d) Unknown. (3d) Both good. (4th) There is none; into the court-yards; cleaning wanting. (5th) From the river; good and hard; containing limestone. (6th) No. (7th) Surrounded by rocks; calcareous soil; no marshes; few fevers. (8th) At 50 meters. (9th) There is none. (10th) Former more severe. (11th) Upon the river. (12th) The lower part, by 2 per cent. more. (13th) By land. (14th) Cordons before the first case, disinfectants afterwards. (15th) Abuse of unripe olives. (16th) In the river, in the lower part of the village. (17th) 57 days—ascend, 16; apogee, 17; descent, 24. (18th) Began two days after a storm, and with rain fulminant cases occurred. (19th) Yes. (20th) 118 attacks—43 men, 56 women, 19 children. (21st) 28 deaths—7 men, 17 women, 4 children. (22d) In the lower, 70; in the upper, 48; to the north, 52; to the south, 66. (23d) There are none.

*Tauste*, 4,150 inhabitants.—(1st answer.) From the 25th of July to the 2d of September. (2d) There are none. (3d) First good; second fair. (4th) There is none; cleaning by the municipality; night-soil in the court-yards. (5th) From the river Ebro; good. (6th) No. (7th) Calcareous; no marshes; rare intermittent fevers; there are some in October. (8th) At 800 meters. (9th) There is none. (10th) The former were benign, and the village was in a worse hygienic condition. (11th) In a dry locality, at a great distance from rivers and streams. (13th) Neighboring roads. (14th) Disinfectants, hygiene and public cleaning. (15th) No. (16th) In the public lavatory. (17th) 39 days—ascend, 9; apogee, 6; descent, 24. (18th) Yes; after storms the cholera developed. (19th) Yes. (20th) 1,248 attacks—539 males,

709 females. (21st) 455 deaths—194 males, 261 females. (22d) Equally. (23d) In the post of the civil guard there were no cases.

*Encinacorva*, 1,092 inhabitants.—(1st answer.) From the 29th of July to the 27th of August. (2d) By communication with infected places. (3d) Unsatisfactory; houses in an ordinary state of healthfulness. (4th) There is none; deposits in the court yards; cleaning by the municipality. (5th) Fountains and wells; good. (6th) No. (7th) Sandy; good topographical position; no fevers. (8th) Almost within the village. (9th) Of iron pipes and aqueducts. (10th) Anterior more. (11th) Upon the river. (12th) Equally. (13th) Neighboring roads. (14th) All. (15th) Yes. (16th) In the river. (17th) 29 days—ascend 12; apogee 8; descent 9. (18th) Yes. (19th) Yes. (20th) 255 attacks—80 men; 106 women; 40 boys 29 girls. (21st) 47 deaths—12 men, 27 women, 8 children. (22d) To the north less than to the south. (23d) There are none. (24th) Failure of public hygiene and privation.

*Luna*, 1,753 inhabitants.—(1st answer.) From the 29th of July to the 22d of August. (2d) By a person. (3d) First good; second miserable. (4th) There is none; in the court-yards; the inhabitants. (5th) Fountains proceeding from the river; good. (6th) No. (7th) Clay; no marshes; intermittent fevers not frequent. (8th) In the center of the village; a temporary one at a kilometer's distance. (9th) There is none. (10th) The former less severe. (11th) Surrounded by the river Ebro. (12th) Equally. (13th) Neighboring roads. (14th) Cordons in the beginning. (15th) Yes. (16th) In the river. (17th) 25 days—ascend 6; apogee 6; descent 13. (18th) Yes. (19th) Yes; with pains in the stomach. (20th) 450 attacks. (21st) 90 deaths. (22d) In the lower. (23d) There are none.

*Farasdués*, 770 inhabitants.—(1st answer.) From the 30th of July to the 4th of September. (2d) By a person. (3d) Both ordinary. (4th) There is none; night-soil in the court-yards. (5th) Fountain water from a spring; good; containing magnesia. (6th) No. (7th) Sandy; marshes at kilometers. (9th) There is none. (10th) Former less severe. (11th) Near a stream. (12th) Equally. (13th) Neighboring highways. (14th) Lazarettos and disinfectants. (15th) Yes. (16th) In the public lavatory and in the stream. (17th) 36 days—ascend 10; apogee 5; descent 11. (18th) Yes. (19th) Yes. (20th) 120 attacks—53 males, 67 females. (21st) 64 deaths—23 males, 41 females. (22d) In the upper; equally to the north and south. (23d) There are none.

*Malanquilla*, 570 inhabitants.—(1st answer.) From the 31st of July to the 9th of September. (2d) By persons. (3d) First good; second bad. (4th) There is none; night-soil emptied outside of the town; inhabitants clean. (5th) Good spring water, containing lime and magnesia. (6th) No. (7th) Clay; no marshes nor fevers. (8th) Within the village. (9th) Of brick. (10th) This was worse. (11th) In a dry locality. (13th) Neighboring roads and highways. (14th) Lazarettos and disinfectants. (15th) There is none. (16th) In public lavatories. (17th) 40 days—ascend, 18; apogee, 13; descent, 9. (18th) Yes. (19th) Yes. (20th) 125 attacks—45 males, 80 females. (21st) 23 deaths—5 males, 18 females. (22d) Unknown. (23d) There are none.

*Alhama de Aragón*, 117 inhabitants.—(1st answer.) From the 2d to the 29th of August. (2d) Unknown. (3d) Both ordinary. (4th) There is none; the night soil runs in open gutters; cleaning by the inhabitants. (5th) Good spring water, containing lime. (6th) No. (7th) Calcareous and clayey; no marshes nor fevers. (8th) At 500 meters. (9th) Of iron pipe, 800 meters long. (10th) Every time with slight force. (11th) Traversed by the Jalón and irrigation canals. (12th) Equally. (13th) Railway and neighboring roads. (14th) Disinfectants. (15th) No. (16th) In public lavatories. (17th) 27 days—ascend, 8; apogee, 12; descent, 7. (18th) Yes, with rains and rise of the Jalón. (19th) Yes. (20th) 72 attacks—28 males, 44 females. (21st) 32 deaths—10 males, 22 females. (22d) In the lower 41; in the upper 31. (23d) No cases in the post of the civil guard.

*Novillas*, 710 inhabitants.—(1st answer.) Three cases to the 30th of September. (2d) By a person. (3d) Both good. (4th) There is none; cleaning by the municipality. (5th) From the Ebro and fountains; good; feruginous, and containing lime and magnesia. (6th) The first house attacked used water from the river Ebro. (7th) Sandy; traversed by running water;



no fevers. (8th) At 300 meters. (9th) There is none. (10th) The anterior less. (11th) Upon the river Ebro, and surrounded by canals. (12th) The principal focus was in the center of the village. (13th) Railways and a highway. (14th) Disinfectants. (15th) Yes. (16th) In the river. (17th) 35 days—ascend, 12; apogee, 6; descent, 17. (18th) Yes. (19th) Yes. (20th) 222 attacks—94 males, 128 females. (21st) 31 deaths—14 males, 17 females. (22d) In the lower, 18; in the upper, 204; to the north, 83; to the south, 139. (23d) There are none.

*Jarque*, 1,205 inhabitants.—(1st answer.) From the 2d of August to the 3d of September. (2d) By mule drivers. (3d) Miserable. (4th) There is none; there are places in which the sewage stands perpetually. (5th) River and fountain water; excellent. (6th) No. (7th) Volcanic, and very porous; no frequent fevers. (9th) There is none. (10th) This time more. (11th) Upon the river Aranda, with numerous affluents. (12th) Equally. (13th) By land. (14th) Fumigations, lazarettos, and disinfectants. (15th) Yes. (16th) In the rivers and canals along its margin. (17th) 32 days. (18th) No. (19th) Yes. (20th) 195 attacks. (21st) 79 deaths—35 males, 44 females.

*Mora de Ebro*, 603 inhabitants.—(1st answer.) From the 4th of August to the 6th of September. (2d) Unknown. (3d) Both bad. (4th) There is none; no public cleaning. (5th) From the Ebro. (6th) Yes. (7th) Sand and clay; no marshes nor fevers. (8th) At 1 kilometer. (9th) There is none. (10th) The former greater; the mildness of this attributed to hygiene. (11th) Upon the Ebro. (12th) The part nearest the river. (13th) By river and neighboring roads. (14th) Disinfectants. (15th) Yes. (16th) In private lavatories whose dirty waters serve for irrigation; washing also in the river. (17th) 33 days—ascend, 8; apogee, 12; descent, 13. (18th) No. (19th) No. (20th) 57 attacks—21 males, 36 females. (21st) 34 deaths—12 males, 22 females. (23d) There are none. (24th) The well-to-do classes were not attacked; only the poor; bad cleaning and want of hygiene.

*Badules*, 425 inhabitants.—(1st answer.) From the 5th of August to the 5th of September. (2d) By persons. (3d) Both miserable. (4th) There is none; no public cleaning. (5th) River water; good. (6th) No. (7th) Calcareous; no marshes, nor fevers. (8th) At 400 meters. (9th) There is none. (10th) Five times greater than this. (11th) Upon a river, at its confluence with a pool constantly containing water. (12th) Equally. (13th) By land. (14th) Cordons and disinfectants. (15th) Yes. (16th) In the river. (17th) 31 days—ascend, 16; apogee, 6; descent, 9. (18th) No. (19th) Yes. (20th) 32 attacks—16 males, 16 females. (21st) 12 deaths—6 males, 6 females. (22) Majority in the lower and to the south. (23d) There are none.

*Valmadrid*, 193 inhabitants.—(1st answer.) From the 6th of August to the 10th of September. (2d) By persons. (3d) First good; the first case occurred in the principal house of the village. (4th) No cleaning nor public hygiene. (5th) From a reservoir supplied by rains. (6th) No. (7th) Clay; no marshes. (8th) At 400 meters. (9th) There is none. (10th) Same as this. (11th) Dry soil. (13th) Highway. (14th) Cordons and lazarettos. (15th) No. (16th) In basins in the house. (17th) 35 days. (18th) No. (19th) No. (20th) 13 attacks—6 men, 4 women, 2 girls, 1 boy. (21st) 6 deaths—2 males, 4 females.

*Pomer*, 440 inhabitants.—(1st answer.) From the 10th of August to the 2d of September. (2d) Suspected by persons. (3d) First good; second bad. (4th) There is none; cleaning by the municipality. (5th) Good spring water. (6th) No. (7th) Calcareous and sandy; no marshes nor fevers. (8th) Within the village. (9th) There is none. (10th) The former less severe. (11th) On the side of a hill. (12th) Equally. (13th) By land. (14th) Cordons, disinfectants, fumigations, and isolation. (15th) Yes. (16th) In the stream, 6 kilometers distant. (17th) 23 days—ascend, 10; apogee, 5; descent, 8. (18th) Yes. (19th) No. (20th) More than 100 attacks. (21st) 18 deaths—6 males, 12 females. (22d) In the upper and to the east. (23d) There are none.

*Alfamen*, 647 inhabitants.—(1st answer.) From the 13th of August to the 8th of September. (2d) Unknown. (3d) Both bad. (4th) There is none; cleaning by the inhabitants. (5th) Agreeable; well water. (6th) No. (7th) Clay; rain-water reservoir; intermittent fevers infrequent. (8th) At the commencement of the epidemic it was removed to 400 meters distance.

(9th) There is none. (10th) Clay. (13th) By land. (14th) All. (15th) No. (16th) In private basins outside of the house. (17th) 26 days—ascend, 5; apogee, 5; descent, 16. (18th) Yes. (19th) Yes. (20th) 38 attacks. (21st) 32 deaths—12 males, 20 females. (22d) In the lower, 12; in the upper, 20.

*Undues Pintano*, 402 *inhabitants*.—(1st answer.) From the 15th of August to the 4th of September. (2d) Unknown. (3d) First bad; second ordinary. (4th) There is none; cleaning by the inhabitants. (5th) Good; spring water; containing lime. (6th) No. (7th) Calcareous and clayey; no marshes nor fevers. (8th) At 1 kilometer. (9th) There is none. (10th) That of 1834 more severe; that of 1855 less. (11th) Between two streams; the one lower, the other higher than the village. (12th) Equally. (13th) Highway. (14th) Disinfectants and hygiene. (15th) Little. (16th) In the streams. (17th) 20 days—ascend, 4; apogee, 12; descent, 4. (18th) Broke out 5 days after a severe storm. (19th) No. (20th) 175 attacks—57 men, 102 women, 16 children. (21st) 25 deaths—8 men, 12 women, 5 children. (22d) Equally. (23d) There are none.

*Mesones*, 782 *inhabitants*.—(1st answer.) From the 20th of August to the 27th of September. (2d) Unknown. (3d) Both bad. (4th) Everything wanting. (5th) Fountains, springs, canals, and river; the last preferred. (6th) No. (7th) Good; sandy and siliceous; no marshes nor fevers. (8th) At 200 meters. (9th) There is none. (10th) Little difference. (11th) The river flows near the houses. (12th) Equally. (13th) Highways. (14th) All. (15th) Much. (16th) In the canals and river. (17th) 38 days—ascend, 20; apogee, 8; descent, 10. (18th) Not observed. (19th) No. (20th) 66 attacks—47 men, 10 women, 9 children. (21st) 24 deaths—10 males, 14 females. (22d) Equally; to the west, 20; to the east, 4. (23d) There are none.

*Torrelas*, 920 *inhabitants*.—(1st answer.) From the 20th of August to the 18th of September. (2d) By persons. (3d) First good; second bad. (4th) There is none; cleaning by the municipality. (5th) Good; spring water. (6th) No. (7th) Clay; no marshes; fevers are frequent. (8th) Near the village. (9th) There is none. (10th) The former less grave. (11th) Upon the River Magallon. (12th) Equally; in a high street containing 7 inhabitants there was no attack. (13th) By land. (14th) All. (15th) Yes. (16th) In the River Magallon. (17th) 29 days—ascend, 8; apogee, 10; descent, 11. (18th) Yes. (19th) Yes. (20th) 218 attacks—80 males, 138 females. (21st) 36 deaths—12 males, 24 females. (22d) All in the lower. (23d) There are none. (24th) In an upper street, inhabited by 7 persons, especially by those engaged in the burial of the dead, not a single case.

*Alconchel*, 660 *inhabitants*.—(1st answer.) From the 12th of August to the 13th of September. (2d) Unknown. (3d) First good; second fair. (4th) There is none; the inhabitants clean. (5th) Good spring, fountain, and well water, containing lime and magnesia. (6th) No. (7th) Calcareous and sandy; no marches nor fevers. (8th) At 400 meters. (9th) Supposed to be of brick. (10th) Little difference. (11th) No. (12th) There is no river. (13th) By land. (14th) All. (15th) Yes. (16th) In public lavatories. (17th) 32 days—ascend, 10; apogee, 10; descent, 12. (18th) Unknown. (19th) Yes. (20th) 99 attacks—41 males, 58 females. (21st) 11 deaths—4 males, 7 females. (22d) In the lower; to the north, 39; to the south, 60. (23d) There are none. (24th) The deficiency of food, as well as the want of good hygienic conditions of the houses, considered to be the cause of the epidemic.

*Brea*, 1,824 *inhabitants*.—(1st answer.) From the 25th of August to the 19th of September. (2d) By persons. (3d) First fair; second worse. (4th) There is none; cleaning by the inhabitants. (6th) From the river Aranda, good; from good fountains. (6th) No. (7th) Clay. (8th) At 300 meters. (9th) There is none. (10th) That of 1855 much more. (11th) At 500 meters above the river. (12th) Equally. (13th) Highways. (14th) Cordons, lazarettos, and disinfectants. (15th) Yes. (16th) Usually in the house. (17th) 25 days—ascend, 7; apogee, 6; descent, 12. (18th) Yes. (19th) Yes. (20th) 45 attacks—13 males, 32 females. (21st) 7 deaths—1 male, 6 females. (22d) In the upper. (23d) There are none.

*Undues de Lerda*, 614 *inhabitants*.—(1st answer.) From the 26th of August to the 4th of November. (2d) Unknown. (3d) First good; second bad. (4th) There is none; cleaning by the inhabitants. (5th) Good spring water. (6th) No. (7th) Rock; no marshes nor fevers.



(8th) At 800 meters. (9th) There is none. (10th) Former less. (11th) There is a pool at 300 meters from the village. (12th) Equally. (13th) Many neighboring roads. (14th) Hygiene and fumigation. (15th) No. (16th) In the pool. (17th) 70 days—ascend, 20; apogee, 30; descent, 20. (18th) Yes. (19th) Yes. (20th) 104 attacks—62 males, 42 females. (21st) 30 deaths—7 males, 23 females. (22d) All in the upper. (23d) There are none.

*Caspe, 657 inhabitants.*—(1st answer.) From the 11th of July to the 20th of August. (2d) Imported by the water of the river Ebro and by harvesters proceeding from infected points. (3d) Miserable. (4th) Sewers defective and unserviceable. (5th) From the river Guadalupe and the Ebro. (6th) Yes; from the Ebro. (7th) Situated upon a hill composed of clay and limestone; slightly porous and damp. (11th) Situated at the confluence of the rivers Guadalupe and Ebro. (12th) The higher and cleaner part suffered more than the lower, which was in a worse hygienic condition. (13th) By land. (14th) Cordons, lazarettos, and fumigations. (15th) Not of fruits, but abuse of alcohol. (17th) 40 days—ascend, 30; apogee, 5; descent, 5. (18th) Coincided with rains and storms. (20th) 1,111 attacks. (21st) 248 deaths. (23d) The communication between the Huertas and the agricultural districts and the families residing in the towns were the principal causes of the importation. (24th) Excepting Zaragoza the other villages upon the Guadalupe, up-stream, were invaded after Caspe.

#### PROVINCE OF CUENCA.

*Montalvo, 1,043 inhabitants.*—(1st answer.) From the 17th of June to the 24th of August. (2d) By persons from infected places. (3d) First ordinary; second bad. (4th) There is none; night soil in receptacles within the houses, or in places within the town. (5th) Well water; good and agreeable. (6th) Believed yes. (7th) Sulphate of lime rock; at 1,100 meters; there is a lake with nitrate deposits; there are no fevers. (8th) At 1 kilometer. (9th) There is none. (10th) Less this time. (13th) By land. (14th) Nothing. (15th) Abuse of fruits and vegetables. (16th) In a storm. (17th) 68 days. (18th) No. (19th) No. (20th) 66 attacks—25 males, 41 females. (21st) 28 deaths—11 males, 17 females. (22d) Only lower stories; majority to the south.

*La Barra, 612 inhabitants.*—(1st answer.) From the 3d to the 27th of July. (2d) By persons from infected places. (3d) First good; second bad. (4th) There is none; everything wanting. (5th) Spring and well water; good, containing some magnesia. (6th) No. (7th) Clay and limestone; no marshes nor fevers. (8th) At 100 meters. (9th) Nothing. (10th) The former less. (11th) No; the nearest at 1 league. (13th) By land. (14th) Cordons at the beginning; afterwards disinfectants. (15th) Abuse of fruits. (16th) In streams and running water; the clothing not given out to wash. (17th) 24 days. (20th) 4 attacks—2 males, 2 females. (21st) 4 deaths—2 males, 2 females. (22d) Lower, and to the east.

*Peralesja, 835 inhabitants.*—(1st answer.) From the 9th of July to the 30th. (2d) By harvesters returning from Aranjuez. (3d) First bad; second ordinary. (4th) There is none; cleaning by the inhabitants. (5th) Saline springs; rain water collected in earthen vessels. (6th) Only one case in the village; the others outside. (7th) In a valley near a stream; there are fevers in spring and autumn. (8th) At 11 meters. (9th) There is none. (10th) In 1885 there was a genuine epidemic, with many cases. (11th) Near the origin of the Júcar. (12th) A single case in the village was distant from a stream. (13th) Highway. (14th) All. (15th) Yes. (16th) In pools. (17th) 21 days. (19th) Yes. (20th) 3 attacks—males. (21st) 2 deaths, beyond the precincts of the village. (24th) An epidemic did not develop because of the isolation, and the extreme care with the sick.

*Cuenca, 8,802 inhabitants.*—(1st answer.) From the 10th of July to the 25th of August. (2d) Unknown. (3d) Both bad. (4th) Sewers in a bad condition; household filth goes into the courts. (5th) Good spring water. (6th) No. (7th) The soil of the upper part, limestone; and the lower, clay; surrounded by canals. (9th) Of masonry, and the distribution lead. (11th) Upon the banks of a stream. (12th) The lower part suffered most. (13th) Railway and roads. (14th) Cordons at the beginning; afterwards disinfection and isolation. (17th) 46 days. (20th) 800 attacks—314 males, 486 females. (21st) 100 deaths. (24th) No village was attacked up-stream.

*Tragacela*, 1,085 inhabitants.—(1st answer.) From the 11th of July to the 18th of September. (2d) By persons. (3d) Both bad. (4th) Everything wanting. (5th) Soft spring water containing lime. (6th) No. (7th) Clay; no marshes nor fevers. (8th) At 340 meters. (9th) There is none. (10th) The former less severe. (11th) At the confluence of the rivers Júcar and Huecar. (12th) The part next to the river, 60 per cent. more. (13th) Highway. (14th) Disinfectants. (15th) No. (16th) In the river. (17th) 68 days—ascend, 17; apogee, 12; descent, 39. (18th) Yes; visible. (19th) No. (20th) 233 attacks—115 males, 118 females. (21st) 70 deaths—36 males, 34 females. (22d) In the lower, 216; in the upper, 17; all to the north. (23d) There is none.

*Valdecabras*, 774 inhabitants.—(1st answer.) From the 11th to the 31st of July. (2d) By person. (3d) Both ordinary. (4th) There is none; the municipality cleans. (5th) Abundance of good water from a stream which enters into a lake, and at its exit the water for the village is taken. (6th) No. (7th) Adjacent to a lake and to the river Júcar. Sandy; there are fevers, and intermittents in the spring. (8th) At 1,200 meters. (9th) There is none. (10th) Never had an epidemic. (11th) The angle formed by the lake and the river. (12th) Equally. (13th) By land. (14th) Nothing. (15th) No. (16th) In the river. (17th) 20 days—ascend, 7; apogee, 7; descent, 6. (18th) 14 hours after a storm. (19th) Yes. (20th) 32 attacks. (21st) 21 deaths. (22d) All in the lower; 5 to the north, and 27 to the south. (23d) There are none.

*Villar de Cañas*, 1,372 inhabitants.—(1st answer.) From the 14th of July to the 14th of September. (2d) It is thought by persons who used water from the river Cancara, where the clothing of cholera patients of the village of Carfa, previously infected to this, was washed. (3d) Both bad. (4th) There is none; every house has a sink, and there is excrement in the court-yards. (5th) Water from a shallow well. (6th) Suspected that the water from the river Cancara was the cause. (7th) Soil, sandy; subsoil, clayey and gravelly; to the northwest there is a lake, which at certain seasons is full of water containing vegetable and animal matter; malarial fevers very frequent. (8th) At 325 meters. (9th) No. (10th) In 1834 more. (11th) On a plain between two rivers; the Cancara at three kilometers, and a small river, Montalvanejo, at a half kilometer. (12th) Equally. (13th) By land. (14th) Disinfectants. (15th) Yes. (16th) In private basins, and also with greater frequency in the river Cancara. (17th) 62 days. (18th) Yes; 24 hours. (20th) 305 attacks—186 males, 119 females. (21st) 88 deaths—37 males, 51 females. (22d) There are no upper stories.

*Cardenete*, 1,442 inhabitants.—(1st answer.) From the 14th of July to the 14th of September. (2d) By persons. (3d) Both bad. (4th) Everything wanting. (5th) Hard, lime, spring water. (6th) Yes. (7th) Sand and granite; no marshes nor fevers. (8th) Within the village. (9th) Of zinc. (10th) Almost all the epidemics were light. (11th) At the confluence of two rivers, and two or three kilometers distant. (12th) Unknown. (13th) By land. (14th) All. (15th) Yes. (16th) In streams and pools. (17th) 62 days. (18th) Unknown. (19th) Unknown. (20th) 9; attacks—6 men, 1 woman, and 2 children. (21st) 6 deaths—5 males, 1 female. (22d) In the lower, and to the south. (23d) There are none.

*Honrubia*, 1,590 inhabitants.—(1st answer.) From the 16th of July to the 3d of September. (2d) By persons from infected places. (3d) Both bad. (4th) Everything wanting. (5th) Well-water, source unknown; soft, containing some magnesia. (6th) No. (7th) Clay; no marshes, no fevers. (10th) This time much more. (13th) By land. (14th) By isolation and disinfectants. (15th) Abuse of fruits and salads. (16th) In a stream at half a league. (17th) 49 days—ascend 10; apogee, 8; descent, 31. (18th) On the 26th of June there was a storm, and the epidemic began 21 days after. (20th) 150 attacks—young people and women suffered most. (21st) 21 deaths—6 males, 15 females. (22d) All in the lower; to the north, 40; to the south, 30; but the rest to the east and west.

*Castejón*, 810 inhabitants.—(1st answer.) From the 19th of July to the 19th of August. (2d) By contact with persons and effects from Cuenca. (3d) Both bad. (4th) There is none; night-soil emptied into the court-yards; cleaning by the inhabitants. (5th) Rain-water, collected in pools; good, containing magnesia. (6th) Unknown. (7th) Calcareous; no marshes



nor frequent fevers. (8th) At 225 meters. (9th) There is none. (10th) In 1855 there were three cases. (11th) At 1 kilometer from a small stream. (12th) Equally. (13th) By land. (14th) Disinfectants and isolation. (15th) Yes. (16th) Washing in the rivers and in the streams. (17th) 31 days. (18th) Yes. (19th) Yes. (20th) 3 attacks—1 male, 2 females. (21st) 3 deaths—1 male, 2 females. (22d) In the lower all three, to the south one, to the east two. (23d) There are none.

*Cañavate, 422 inhabitants.*—(1st answer.) From the 24th of July to the 7th of August. (2d) By persons from infected places. (3d) First good, second bad. (4th) There is none; no public cleaning. (5th) Good spring water. (6th) No. (7th) Clay; fevers frequent in summer and autumn. (8th) At 500 meters. (9th) There is none. (10th) No former epidemic. (11th) Upon a stream. (13th) By land. (14th) Nothing. (15th) There are no fruits. (16th) In pools from springs and in streams. (17th) 14 days. (18th) No. (19th) No. (20th) 11 attacks—5 males, 6 females. (21st) 6 deaths—2 males, 4 females. (22d) The houses only one story.

*Cervera, 1,096 inhabitants.*—(1st answer.)—From the 26th of July to the 14th of September. (2d) By harvesters from Tarragona. (3d) First good, second bad. (4th) There are none; night-soil thrown into uncovered receptacles. (5th) Springs and wells; pleasant. (6th) No. (7th) Sandy; no marshes nor fevers. (9th) Of brick. (10th) Less this time. (13th) By land. (14th) Cordons and disinfectants. (15th) Yes, but prohibited. (16th) In a stream; washing not given out. (17th) 50 days—ascend, 40; descent, 10. (18th) Yes; immediately. (19th) No. (20th) 525 attacks—307 males, 218 females. (21st) 58 deaths—30 males, 28 females. (22d) Lower stories.

*Almendros, 1,137 inhabitants.*—(1st answer.) From the 26th of July to the 25th of August. (2d) By persons from infected places. (3d) The first good, the second very bad. (4th) There is none; cleaning by the inhabitants. (5th) Wells; good and agreeable. (6th) No. (7th) Clay; fevers not frequent. (8th) At 1,000 meters. (10th) This time more. (16th) By neighboring roads. (14th) Lazarettos for the sick, watching along the roads, and disinfectants. (15th) Sale of fruit prohibited. (16th) In the houses. (17th) 30 days. (19th) Yes. (20th) 5 attacks—3 males, 2 females. (21st) 4 deaths—2 males, 2 females. (22d) In the lower; to the north 2, to the south 3.

*Pajaroncillo, 356 inhabitants.*—(1st answer.) From the 26th of July to the 23d of August. (2d) By persons from Cuenca, who were inhabitants of this town. (3d) Ordinary. (4th) There is none; no public cleaning. (5th) Well and spring water; good, pleasant, containing magnesia. (6th) No. (7th) Clay; no marshes, but fevers are frequent in spring and autumn. (8th) Near the village. (9th) There is none. (10th) More this time. (11th) At 100 meters from a stream and at 400 meters from another. (12th) The northern part, near the stream, most affected. (13th) By land. (14th) Cordons and disinfectants. (15th) Abuse of fruits and vegetables. (16th) In the streams, by those interested. (17th) 28 days—ascend, 4; apogee, 14; descent, 10. (18th) No. (19th) Yes. (20th) 109 attacks—84 males, 25 females. (21st) 32 deaths—12 males, 20 females. (22d) In the lower. (24th) Those who fled escaped.

*Salvacañete, 1,375 inhabitants.*—(1st answer.) From the 21st of July to the 28th of August. (2d) Not known for certain; suspected by the river water. (3d) Both bad. (5th) Spring water and river water; good and containing iron. (6th) It is believed that all the first attacked drank river water. (7th) Clay; no marshes, nor fevers. (8th) Within the village surrounded by inhabited houses. (9th) Of wood. (10th) That of 1855 the same as this. (11th) The river and streams passed below at considerable distance. (12th) Equally. (13th) By land. (14th) Cordons and disinfectants. (15th) No. (16th) In the river; and in basins supplied by the public fountain. (17th) 38 days; ascent 10; apogee, 10; descent, 18. (18th) Not noted. (19th) No. (20th) 170 attacks—70 males, 100 females. (21st) 43 deaths—20 males, 23 females. (22d) All in the lower and equally to the north and south. (23d) There are none. (24th) Refused to take medicine; many deaths without medical assistance.

*Bellinchón, 1,417 inhabitants.*—(1st answer.) From the 1st of August to the 7th of September. (2d) Attributed to seven persons eating beef blood cooked in Tarancon, an infected place, and brought to the village. Of the seven who ate, five died. (3d) All fair; much

dampness. (4th) There is none ; no public cleaning. (5th) Fountain water ; good ; containing lime. (6th) No. (7th) Calcareous ; no marshes, nor frequent fevers. (8th) At 100 meters. (9th) Of brick. (10th) Former epidemics gave more deaths. (11th) At 11 kilometers from the Tajo. (13th) Highways and neighboring roads. (14th) Disinfectants, fumigations and isolation. (15th) During the cholera, there was abstention. (16th) In the houses, and in the public lavatory ; the clothing of cholera patients in separate pools. (17th) 37 days—ascend, 14 ; apogee, 1 ; descent, 22. (18th) Rains coincided with the descent of the epidemic at the end of August. (19th) No. (20th) 228 attacks—78 males, 150 females. (21st) 46 deaths—14 males, 32 females. (22d) All in the lower ; to the north 57, to the south 65. (23d) There are none.

*Alcantud, 445 inhabitants.*—(1st answer.) From the 2d to the 18th of August. (2d) Believed to be spontaneous. (3d) First good, second bad ; the first case in a flour-mill at 300 meters from the village. (4th) There is none ; inhabitants clean. (5th) Spring water and river water. (6th) No. (7th) Granite ; there is an infected lake ; frequent fevers. (8th) At 200 meters. (9th) There is none. (10th) In 1855, three times greater. (11th) At 200 meters from the stream. (12th) Near the stream, four times more attacks. (13th) Highways. (14th) Vigilance and fumigations. (15th) Yes ; but abstention during the epidemic. (16th) In the stream ; also in each house. (17th) 16 days—ascend, 8 ; apogee, 3 ; descent, 5. (18th) Yes. (19th) Yes. (20th) 34 attacks—20 males, 14 females. (21st) 11 deaths—6 males, 5 females. (22d) In the upper 8, in the lower 26 ; to the north 18 and to the south 16. (23d) There are none.

*Santa María de los Llanos, 834 inhabitants.*—(1st answer.) From the 3d of August to the 18th of September. (2d) Unknown. (3d) First good, second bad. (4th) There is none ; inhabitants remove the excrement in the autumn. (5th) Spring water, in wells containing lime and magnesia. (6th) Yes. (7th) Granite and clay and limestone ; no marshes ; in ordinary seasons there are fevers. (8th) At 200 meters. (10th) In 1834 less. (11th) Upon a river to the south, and a stream to the west. (12th) Equally. (13th) By land. (14th) Cordons and disinfectants. (15th) Yes. (16th) In streams and private basins. (17th) 46 days—ascend, 19 ; apogee, 12 ; descent, 15. (18th) No. (19th) Yes. (20th) 154 attacks—57 males, 97 females. (21st) 88 deaths—34 males, 54 females. (22d) In upper stories.

*Barchin del Hoyo, 469 inhabitants.*—(1st answer.) From the 16th of August to 6th of September. (2d) Unknown. (3d) First good, second ordinary. (4th) There is none ; cleaning by the municipality. (5th) Fountain water and spring water in wells ; agreeable and containing magnesia. (6th) No. (7th) Sandy and clay ; no marshes ; few intermittent fevers in summer and autumn. (8th) At 250 meters. (9th) Of brick. (10th) Former less. (11th) Near a small stream. (12th) Lowest part suffered most. (13th) By land. (14th) Cleaning of the village and disinfectants. (15th) Yes ; predominance of peppers, tomatoes, and cucumbers. (16th) In the streams and private basins. Not given out to wash. (17th) 21 days. (18th) Ceased with rains. (19th) Yes. (20th) 70 attacks—35 males, 35 females. (21st) 30 deaths—16 males, 14 females. (22d) Lower ; to the north 8, to the south 52.

*Torrejoncillo del Rey, 1,760 inhabitants.*—(1st answer.) From the 17th to the 27th of August. (2d) By persons who were in infected places. (3d) First, ordinary ; second bad. (4th) There is none ; whoever pleases cleans. (5th) Agreeable, hard spring water. (6th) No. (7th) Calcareous ; no marshes nor fevers. (8th) At 500 meters. (9th) Of brick. (10th) The former a little more. (11th) Upon a near stream. (13th) By land. (14th) Cordons with isolation and disinfectants. (15th) Abuse of fruits and vegetables. (16th) In the houses and streams. (17th) 10 days—ascend, 3 ; apogee, 2 ; descent, 5. (18th) No. (19th) No. (20th) 12 attacks—4 males, 8 females. (21st) 6 deaths—3 males, 3 females. (22d) Only the lower inhabited.

*Loranca del Campo, 754 inhabitants.*—(1st answer.) From the 11th of August to the 19th of September. (2d) Both ordinary. (4th) Everything wanting. (5th) Fountain water ; agreeable. (6th) No. (7th) Calcareous ; no marshes, nor intermittent fevers. (8th) At 500 meters. (9th) Of iron and brick. (10th) There were no anterior. (11th) No. (12th) The lowest part. (13th) Highways. (14th) Disinfectants. (15th) Salads and vegetables. (16th) In public lava-



tories. (17th) 39 days. (18th) With clear weather. (19th) Yes. (20th) 119 attacks—31 males; 88 females. (22d) 22 deaths—9 males, 13 females.

*Pozo Amargo*, 677 inhabitants.—(1st answer.) From the 21st of August to the 11th of September. (2d) Unknown. (3d) Both bad. (4th) All public service wanting. (5th) Good well-water, containing magnesia. (6th) No. (7th) Sandy; no marshes, nor frequent fevers. (8th) At 400 meters. (9th) There is none. (10th) This time less than the former. (11th) In a plain; there is no river. (13th) By land. (14th) Cordons. (15th) No. (16th) In private basins and in the houses. (17th) 21 days—ascend, 5; apogee, 3; descent, 13. (18th) Yes. (19th) Yes. (20th) 65 attacks—25 males, 40 females. (21st) 29 deaths—18 males, 11 females. (22d) All in the lower; 25 to the north, 40 to the south. (23d) There are none.

*Fuente de Pedro Najarro*, 1,441 inhabitants.—(1st answer.) From the 16th of August to the 21st of September. (2d) Supposed to be due to water of the river Rianzares, which passed by the village Tarracon, an infected place. (3d) Both bad; the town very dirty. (4th) Every kind of public service wanting; nothing done by the municipality. (5th) Good well-water, taken at a kilometer's distance; pleasant to the palate. (6th) Unknown. (7th) Sandy; there are neighboring marshes and canals connecting with the river; fevers very frequent. (8th) At 400 meters. (9th) There is none. (10th) Unknown. (11th) Near the river, in a plain, and near the canals. (12th) Majority near the river. (13th) Highways. (14th) Cordons and disinfectants. (15th) Yes. (16th) In public lavatories, and in the houses. (17th) 36 days—ascend, 6; apogee, 6; descent, 24. (18th) Descent coincided with heavy rains; was rapid, but lasted quite 24 days. (19th) Yes; from the beginning to the end of the epidemic; much in the form of cholera. (20th) 111 attacks—51 males, 60 females. (21st) 31 deaths—14 males, 17 females. (22d) All in the lower; equally to the north and south. (23d) There are none.

*Carrascosa del Campo*, 1,739 inhabitants.—(1st answer.) From the 24th of August to the 15th of September. (2d) By persons from infected places. (3d) Both bad. (4th) Public service wanting; deposits in the court-yards of the houses; no sewerage. (5th) Well-water; good, hard, saline, and calcareous. (6th) No. (7th) Clay, compact; no marshes nor frequent fevers. (8th) At 800 meters. (9th) No. (10th) The same. (11th) Surrounded by two small streams. (13th) Roads and railways. (14th) Both. (15th) Yes; especially in peppers, tomatoes, and cucumbers. (16th) Of all kinds. (17th) 22 days—ascend, 13; apogee, 4; descent, 5. (18th) No. (19th) No. (20th) 18 attacks—10 males, 8 females. (21st) 7 deaths—3 males, 4 females. (22d) In the lower worst, 15, and 3 in the upper.

*Mota del Cuervo*, 3,173 inhabitants.—(1st answer.) From the 25th of August to the 2d of October. (2d) By persons from infected places. (3d) Both ordinary. (4th) Only in some streets; the cleaning by the inhabitants. (5th) Good springs. (7th) Clay; there are marshes and intermittent fevers in autumn. (8th) There are two; one in the center and the other at 500 meters; the first was closed during the epidemic. (9th) There is none. (10th) More this time. (11th) No. (13th) By land. (14th) Both. (15th) Much; of watermelons, cantaloups, and tomatoes. (16th) In the houses, in casks, and in basins. (17th) 38 days. (18th) No. (19th) No. (20th) 14 attacks—7 males, 7 females. (21st) 6 deaths—4 males, 2 females. (22d) Equally.

*Salinas del Manzano*, 508 inhabitants.—(1st answer.) From the 29th of August to the 19th of September. (2d) Supposed imported by persons from three neighboring infected villages. (3d) First good; second bad. (4th) There is none; the excrement into court-yards, and afterwards removed in carts. (5th) Spring water. (6th) Unknown. (7th) Predominance of lime and clay; no marshes nor frequent intermittent fevers. (8th) At 400 meters. (9th) Of brick. (10th) In 1855 no cases. (11th) Upon a small stream. (13th) By land. (14th) Cordons before they were prohibited; afterwards disinfectants. (15th) No fruits during the epidemic. (16th) In the streams, by each person. (17th) 21 days. (18th) No. (19th) Yes. (20th) 4 attacks—1 male, 3 females. (21st) 4 deaths—1 male, 3 females. (22d) All in the upper and to the south.

*Alarcón*, 846 inhabitants.—(1st answer.) From the 28th of August to the 3d of September. (2d) By an individual who accompanied a family from an infected point, and it is believed by the clothing or by the food. (3d) The first good, the second bad, and without ventilation.

(4th) There is none; night-soil deposited in the houses and removed to the fields by the inhabitants. (5th) From the river Júcar and a fountain at the margin of the river; good, agreeable. (6th) No. (7th) Alluvium and quartz rock, lime, and potassium of soda. There is a plain of 200 meters; frequent fevers in autumn. Soil is clayey and sandy. (8th) At 100 meters. (9th) Of brick. (10th) More in the former. (11th) Upon the river Júcar. (13th) By land. (14th) Cordons before and disinfectants after the former were prohibited. (15th) Yes. (16th) Very near the river. (17th) 7 days. (18th) Coincided with rains and fogs. (19th) Some cases of intestinal disorders. (20th) 3 attacks—2 males, 1 female. (21st) 3 deaths—2 males, 1 female. (23d) In the lower, and to the north.

*Pedernoso, 1,412 inhabitants.*—(1st answer.) From the 30th of August to the 29th of September. (2d) By clothing from Santa Maria de los Llanos. (3d) Both bad. (4th) There is none; night-soil deposited in the courts of the houses. (5th) Well-water containing lime and magnesia. (6th) No. (7th) Situated in a hollow at the confluence of three damp plains. (8th) Adjoining. (9th) There is none. (10th) Less in 1855. (11th) The river at 3 kilometers. (13th) Highways and neighboring roads. (14th) All; principally disinfectants in the houses and of persons. (15th) Ordinarily grapes and cantaloups. (16th) In the river; the well-to-do classes give their washing out. (17th) There were two periods; the first from the 30th of August to the 3d of September, and the second from the 16th to the 29th of September. (18th) There was storm and rain on the 29th of August. (19th) Yes. (20th) 48 attacks—17 males, 31 females. (21st) 14 attacks—6 males, 8 females. (22d) There are no upper stories; to the north, 30; to the south, 18.

*Villaneuva de la Jara, 2,457 inhabitants.*—(1st answer.) From the 5th of August to the 10th of October. (2d) By contact with persons from infected places. (4th) There is none, (5th) Well and river water; fair. (9th) There is none. (11th) Upon an affluent of the Júcar. (13th) By land. (14th) Cordons, isolation, and quarantine. (20th) 57 attacks. (21st) 38 deaths.

*Motilla del Palancar, 2,730 inhabitants.*—(1st answer.) From the 4th of August to the 17th of September. (2d) Introduced by contact with persons from Quintavar del Rey, and by two washerwomen of dirty clothes. (3d) Both bad. (4th) There is none. (5th) Well-water. (9th) There is none. (11th) In a damp valley near the Júcar. (13th) Highways. (14th) Isolation and cordons. (17th) 44 days. (20th) 800 attacks. (21st) 170 deaths.

#### PROVINCE OF HUESCA.

*Paleñino, 508 inhabitants.*—(1st answer.) From the 11th of June to the 12th of August. (2d) Reason to suppose by persons from Canagoza. (3d) First fair; second bad. (4th) There is none; cleaning by the municipality. (5th) Rain-water, collected in tanks; also, distant springs, when the first is scarce. (6th) No. (7th) Alluvium of the river Flumen; there are fevers; more in autumn. (8th) The old in the village; the new at 1 kilometer. (10th) That of 1855 less. (11th) Upon the river Flumen. (12th) Equally. (13th) Neighboring roads. (14th) Disinfectants, fumigations and isolation. (15th) No. (16th) In the river. (17th) 32 days, in two periods; ascent and descent equal. (18th) Yes. (19th) Yes. (20th) 34 attacks—15 males, 19 females. (21st) 10 deaths—5 males, 5 females. (22d) Equally in the upper and in the lower.

*Oso, 706 inhabitants.*—(1st answer.) From the 1st of August to the 7th of September. (2d) By inhabitants. (3d) First bad; second good. (4th) There is none; cleaning by the municipality. (5th) Used river and spring water containing magnesia. (6th) No. (7th) Granite and limestone; no marshes; few fevers in autumn. (8th) At 1,200 meters. (9th) There is none. (10th) Former greater. (11th) Situated at 500 meters from the river, to the east. (12th) Equally to the north and to the south. (13th) By land. (14th) Cordons and disinfectants. (15th) Yes. (16th) In the streams and the river. (17th) 38 days—ascent, 20; apogee, 7; descent, 11. (18th) Yes. (19th) Yes. (20th) 61 attacks—27 males, 34 females. (21st) 21 deaths—10 men, 5 women, 6 children. (22d) All in the lower; 19 to the north; 42 to the south. (23d) There are none.



*Albalate de Cinca*, 1,366 *inhabitants*.—(1st answer.) From the 1st of August to the end of September. (2d) Unknown. (3d) Both bad. (4th) There is none; cleaning by the municipality. (5th) River and fountain water; good. (6th) No. (7th) Sandy and clayey; endemic fevers; increasing in the summer and autumn. (8th) At 500 meters. (9th) Natural conduits. (10th) In 1855 there were more deaths, but less attacks. (11th) Upon the river Cinca, and it is surrounded by canals. (12th) Equally. (13th) Neighboring roads, (14th) All. (15th) Yes. (16th) In the river and canals. (17th) 61 days—irregular march. (18th) Yes. (19th) Yes. (20th) 118 attacks—46 males, 72 females. (21st) 29 deaths—14 males, 15 females. (22d) 52 in the lower, 66 in the upper; 76 to the north, 42 to the south. (23d) There are none.

*Agüero*, 1,184 *inhabitants*.—(1st answer.) From the 14th to the 31st of August. (2d) By persons. (3d) First good; second fair. (4th) Of stone; no public service; the cleaning by the inhabitants. (5th) Good spring water. (6th) No. (7th) Clay soil; no marshes; fevers unknown. (8th) The old, in the village; the new, at a quarter league. (9th) Of stone. (10th) More in the former. (11th) There is a viaduct at a quarter of a league. (13th) Mountain roads. (14th) Isolation and disinfectants. (15th) No. (16th) In the public lavatories. (17th) 17 days—ascend, 4; descent, 13. (18th) Coincided with excessive heat. (19th) Yes. (20th) 6 attacks—3 males, 3 females. (21st) 5 deaths. (22d) All to the north. (23d) There are none.

*Monflorite*, 312 *inhabitants*.—(1st answer.) From the 6th to the 28th of August. (2d) Spontaneous. (3d) Both bad. (4th) There is none; night-soil deposited in the court-yards. (5th) Natural springs, well, and canal. (7th) Sandy; frequent fevers. (8th) Within the village. (9th) There is none. (10th) Less this time. (11th) The principal part of the town and the mills are near the river Flumen, Pompenello adjoining the river Smelo. (12th) 16 died in the houses nearest the river; 2 in the mills most distant. (13th) There are no roads. (15th) No. (16th) In the rivers. (17th) 22 days. (18th) Yes. (19th) Yes. (20th) 75 attacks—43 males, 32 females. (21st) 18 deaths—10 males, 8 females. (22d) More to the south.

*Sena*, 1,032 *inhabitants*.—(1st answer.) From the 21st of August to the 17th of September. (2d) By a person. (3d) First, good; second, bad. (4th) There is none; cleaning in charge of the board of health. (5th) From the river; of good quality; containing lime and magnesia. (6th) No. (7th) Clay and sand; no marshes nor fevers. (8th) At 500 meters. (9th) There is none. (10th) Less than others. (11th) At 1 kilometer from the river; high elevation. (12th) The part near the river suffered a third less. (13th) By land and rivers. (14th) Disinfectants. (15th) Yes. (16th) In the river and in the canals. (17th) 28 days—ascend, 8; descent, 20. (18th) Yes. (19th) Yes. (20th) 87 attacks—30 men, 45 women, 12 children. (21st) 23 deaths—8 males, 15 females. (22d) Not observed. (23d) There are none.

*Sandinies*, 200 *inhabitants*.—(1st answer.) From the 30th of August to the 15th of September. (2d) By a person. (3d) Both bad. (4th) There is none; cleaning by the inhabitants. (5th) Good spring water, containing some nitrate of potassium. (6th) No. (7th) Calcareous; no marshes nor intermittent fevers. (8th) At 200 meters from the village. (9th) There is none. (10th) Never suffered before. (11th) Very distant from the river. (12th) In the center of the town, the most. (13th) Highways. (14th) Disinfectants. (15th) No. (16th) In running water from springs. (17th) 16 days—ascend, 8; apogee, 4; descent, 4. (18th) No. (19th) Yes. (20th) 22 attacks—5 males, 17 females. (21st) 6 deaths—3 males, 3 females. (22d) In the lower, 14; in the upper, 8. (23d) There are none.

#### PROVINCE OF MADRID.

*Ciempozuelos*, 2,504 *inhabitants*.—(1st answer.) From the 12th of June to the 22d of August. (2d) Supposed by excrement deposited upon the ground and at the entrance to the Hermitage of Angeles, which was used as a lazaretto the previous year. (3d) Bad, in general. The epidemic began in different points separated from each other, and in well-built, damp and unhealthy houses. (4th) All public service wanting. (5) From the river Jarama, and from the canal derived from the same. Good only at the time of thawing of

the river Guadarrama; at other times it contains a considerable quantity of organic substances. An analysis during the epidemic showed 2.70 centigrades of organic matter. (7th) The soil contains gypsum, potassa, and soda; fevers are frequent in September; sometimes malignant. (8th) In the center; during the epidemic this was closed, and another was established at a kilometer's distance. (10th) Equally. (11th) At one league from the river Jarama. (13th) Railroads and highways. (14th) Disinfectants. (15th) Abuse of fruits and vegetables. (16th) In the river and in the canal. (17th) 71 days—ascend, 20; apogee, 30; descent, 21. (18th) It was noticed that in the month of bad weather the time of the commencement of the storm coincided with that of the attacks. (19th) No. (20th) 451 attacks—females a third more than males. (21st) 117 deaths—same proportion as of attacks. (22d) The houses are low; more to the south than to the north. (23d) In the insane asylums, the number of attacks in proportion to the population was 3 per cent. of the men, and 58 per cent. of the women.

*Rivas y Vaciamadrid*, 1,102 inhabitants.—(1st answer.) From the 19th of June to the 27th of August. (2d) By persons. (3d) Both good. (4th) There is none; cleaned by the inhabitants. (5th) Good water from the rivers Jarama and Henares. (6th) No. (7th) Sandy and clayey; no marshes, but frequent fevers. (8th) At 25 meters. (9th) There is none. (10th) Never suffered before. (11th) There are three rivers and one stream. (12th) No cases for comparison. (13th) Neighboring roads and highway. (14th) Nothing. (15th) Yes. (16th) In the river. (17th) There were only three cases. (18th) No. (19th) Yes. (20th) 3 attacks—1 male, 2 females. (21st) 3 deaths. (22d) In the lower 3. (24th) There are none.

*Villarejo de Salvanés*, 3,054 inhabitants.—(1st answer.) From the 25th of June to the 9th of September. (2d) First case in a person coming from Ciempozuelos. (3d) First good, second bad. (4th) There is none; inhabitants carry the filth beyond the town. (5th) Spring water; ordinary quality; pleasant and hard. (6th) No. (7th) Clay. There are pools of dirty water in the neighborhood, and the lavatories receive the overflow from them. In autumn and spring, intermittent fevers are common. (8th) At 100 meters. (9th) Of brick. (10th) Little difference. (11th) No. (12th) Equally. (13th) By land. (14th) Cordons, lazarettos, and disinfectants. (15th) Yes. (16th) In public lavatories outside of the houses. (17th) 76 days. (18th) Descent observed after a rain. (19th) Yes. (20th) 257 attacks—103 males, 154 females. (21st) 144 deaths—63 males, 81 females. (22d) There are no upper stories; majority to the north. (24th) The poor and those leading irregular lives and exhibiting fear, were most attacked.

*Torrejón de Velasco*, 1,240 inhabitants.—(1st answer.) From the 29th of June to the 24th of August. (2d) By persons from Aranjuez and Sesena. (3d) Both bad. (4th) There is none; the excrement deposited into the court-yards, and into the *patios* at the entrance of the houses during the year, to be removed thence in September by the inhabitants. (5th) Springs; fair and hard, and containing small quantity of lime. Some use well water. (6th) To those who have constituted foci, they used water from a suspected source. (7th) Sandy and calcareous, and abounding in sulphate of lime; there are no marshes, but there is malarial fever. (8th) At 206 meters. (9th) Of brick. (10th) More in 1855, and in the same streets. (11th) Upon two streams. (12th) In proportion of five to one; it was the same in 1855. (13th) Railway and roads. (14th) Disinfectants, isolation, burning of clothing of the cholera patients. (15th) Yes; especially of cantaleups and watermelons. (16th) In public lavatories, and in the houses. (17th) 56 days—ascend, 19; apogee, 8; descent, 29. (18th) The descent coincided with high winds and rains. (19th) Yes. (20th) 42 attacks—19 males, 23 females. (21st) 15 deaths—6 males, 9 females. (22d) All in the lower; 8 to the north; 34 to the west. (23d) In the post of the civil guard, 1 attack.

*Valdemoro*, 2,167 inhabitants.—(1st answer.) From the 8th of July to the 31st of August. (2d) By a civil guard proceeding from Cuenca, and who fell sick in this village. (3d) The first good; the second bad. (4th) There is none; deposited in the court-yards; cleaning by the inhabitants. (5th) Springs; good and hard. (6th) Yes. (7th) Calcareous soil; no marshes nor intermittent fevers, but on account of being inclosed in a damp valley there was a tendency to them. (8th) At 1 kilometer. (9th) Of brick. (10th) In 1855 more; imported from Madrid.



(11th) No. (13th) Railways and roads. (14th) Isolation and disinfectants. (15th) Yes. (16th) In public lavatories; supplied by the overflow of the public fountains. (17th) 54 days. (18th) No. (19th) Coincided with intemperance in eating and drinking. (20th) 19 attacks—6 males, 13 females. (21st) 13 deaths—4 males, 9 females. (22d) All in the lower; 8 to the north; the rest to the south. (24th) Began in the same house as in 1855; the majority in merchants.

*Alcalá de Henares*, 12,317 *inhabitants*.—(1st answer.) From the 12th of July to the 13th of August. (2d) By persons and by abuse of fruits. (3d) The first good, the second better. (4th) Sewers only in a part of the town; in the other parts there are sinks; the municipality cleans. (5th) Good; spring water; distant from the river. (6th) No. (7th) Clay and limestone; no marshes; few fevers; only in autumn. (8th) At 1 kilometer. (9th) In the country, of brick; in the town, of lead. (10th) That of 1855 was greater; of 1865 less than the last. (11th) The River Henares passes at 300 meters from the village. (12th) 80 per cent. more. (13th) Railway and highways. (14th) Disinfectants. (15th) Yes. (16th) In public lavatories and in the river. (17th) 32 days—ascend, 7; apogee, 9; descent, 16. (18th) No. (19th) Yes. (20th) 813 attacks—335 males, 478 females. (21st) 320 deaths—110 males, 210 females. (22d) 80 per cent. in the lower; 20 per cent. in the upper; equally in other respects. (23d) 90 per cent. of those in the House of Correction, and 17 per cent. of those in the military quarters attacked.

*Vicálvaro*, 2,014 *inhabitants*.—(1st answer.) From the 16th of July to the 30th of August. (2d) By persons with a wagon of wood; coinciding with the time of a storm. (3d) First, good; second, ordinary. (4th) There is none; cleaning by the inhabitants. (5th) Water from three fountains. (6th) No. (7th) Good; sandy; no marshes nor fevers. (8th) At 175 meters. (9th) Of brick. (10th) In 1854, 30 days; in 1865, none. (11th) There is only one stream in the village. (12th) The worst cases were near the stream. (13th) Railways and a highway. (14th) All. (15th) Harmful fruits and vegetables were examined. (16th) In the public lavatories. (17th) 46 days—ascend, 14; apogee, 6; descent, 26. (18th) Yes. (19th) Yes. (20th) 77 attacks—32 males, 45 females. (21st) 39 deaths—19 males, 20 females. (22d) The majority in the lower and to the south. (23d) In the quarters of the artillery, one case, without a death.

*Chamartín de la Rosa*, 1,518 *inhabitants*.—(1st answer.) From the 18th of July to the 13th of August. (2d) By persons and effects in communication with Madrid. (3d) Good. (4th) There is none; wells in many houses, which the inhabitants clean. Public cleaning by the municipality. (5th) Well water in the houses; good, but containing traces of salts. (6th) No. (7th) Sandy in the greater part; no marshes, nor fevers. (8th) At 2 kilometers. (9th) There is none. (10th) Did not suffer in the former. (13th) By land. (14th) Disinfectants and isolation. (15th) Few fruits consumed generally. (16th) In public lavatories, and in Madrid in the Manzanres Canal, which is the sewer. (17th) 26 days. (18th) Did not rain. (19th) Yes. (20th) 9 attacks—5 males, 4 females. (21st) 7 deaths—5 males, 2 females. (22d) In the lower and to the south.

*Fuencarral*, 2,391 *inhabitants*.—(1st answer.) From the 22d of July to the 1st of September. (2d) By persons. (3d) Both bad. (4th) Cleaning by the municipality. (5th) Good spring water. (6th) No. (7th) Sandy; no marshes, nor fevers. (8th) At 100 meters. (9th) Of brick. (10th) Not attacked in 1865. (11th) Upon the covered canal Lozoya. (13th) Highways. (14th) Disinfectants. (15th) Yes. (16th) In the overflow of fountains, and in the canal. (17th) 40 days—ascend, 14; apogee, 10; descent, 16. (18th) Yes. (19th) Yes. (20th) 89 attacks—35 males, 54 females. (21st) 30 deaths—11 males, 19 females. (22d) All in the lower; equally to the north and south. (23d) There are none.

*Villaconejos*, 3,054 *inhabitants*.—(1st answer.) From the 23d of July to the 21st of August. (2d) Uncertain; believed imported from Aranjuez. (3d) Both good. (4th) There is none; excrement removed outside of the town; cleaning by the municipality. (5th) Pleasant spring water containing sulphate of lime. (6th) No. (7th) Soil, sulphate of lime; no marshes, nor frequent intermittent fevers. (8th) At 500 meters. (9th) Iron pipes. (10th) In 1855 less. (11th) No. (13th) By land. (14th) Lazarettos and disinfectants. (15th) Abuse of fruits and

vegetables. (16th) In the houses; in the summer some go to the Tajo, at 8 kilometers. (17th) 29 days. (18th) The 1st of August a slight rain; on the 2d there were more attacks. (19th) No. (20th) 120 attacks—47 males, 73 females. (21st) 24 deaths—9 males, 15 females. (22d) All lower; to the north 45, to the south 53; to the east 2, to the west 20. (24th) It is believed that on account of there being no stagnant water, nor streets which impeded the currents of air, the development of the epidemic was slight..

*Vallecas, 3,280 inhabitants.*—(1st answer.) From the 3d of August to the 9th of September. (2d) Suspected by persons. (3d) Both bad. (4th) There is none; cleaning by the municipality. (5th) Spring water, and the Lozoya wayer; good. (6th) No. (7th) Clay and rock. (8th) At 500 meters. (9th) Of lead and brick. (10th) The former greater except in 1865, when there was none. (11th) Adjoining the stream Abronigal. (13th) Railways and a highway. (14th) Disinfectants and fumigations. (15th) Yes. (16th) In public lavatories. (17th) 36 days—ascend, 10; apogee, 12; descent, 14. (18th) Yes. (19th) Yes. (20th) 185 attacks—65 males, 120 females. (21st) 74 deaths—27 males, 47 females. (22d) The majority in the lower, and equally to the north and south. (23d) There are none.

*Ajalvir, 761 inhabitants.*—(1st answer.) From the 4th of August to the 22d of September. (2d) By persons. (3d) The first good, the second bad. (4th) Public service of every kind wanting. (5th) Good spring water. (6th) No. (7th) Clay; without marshes or fevers. (8th) At 500 meters. (9th) Of brick. (10th) That of 1834 and 1855, greater, but in 1865 there was none. (11th) No rivers nor streams. (13th) Highways. (14th) Disinfectants. (15th) Yes. (16th) In the streams and in the pools. (17th) 50 days—ascend, 18; apogee, 8; descent, 24. (18th) No. (19th) Yes. (20th) 69 attacks—29 males, 40 females. (21st) 37 deaths—20 males, 17 females. (22d) All in the lower.

*Colmevar Viejo, 4,423 inhabitants.*—(1st answer.) From the 11th of August to the 13th of October. (2d) By persons. (3d) First good; second bad. (4th) Bad; cleaning by the municipality. (5th) Springs and rain water; good. (6th) No. (7th) Granite; no marshes; there are fevers; few in autumn. (8th) At 500 meters. (9th) Of lead. (10th) The former more. (11th) No river or stream. (13th) Highway. (14th) Disinfectants. (15th) Yes. (16th) In the river and in the streams at a considerable distance from the village. (17th) 62 days, in two periods, each with a regular march. (18th) Yes. (19th) Yes. (20th) 81 attacks—29 males, 52 females. (21st) 45 deaths—17 males, 28 females. (22d) All in the lower, and equally to the north and south. (23d) There is a prison in which there were seven attacks and two deaths.

*Camarma de Esteruelas, 388 inhabitants.*—(1st answer.) From the 12th of August to the 10th of September. (2d) By persons. (3d) First good; second bad. (4th) There is none; deposited in court-yards, and no public service. (5th) Springs and wells; good; containing magnesia. (7th) Clay; no marshes, but intermittent fever is endemic all the year. (8th) At 200 meters. (9th) There is none. (10th) Less in former. (11th) On the right bank of a near stream. (12th) Equally. (13th) By land and rail. (14th) All kinds of disinfectants in the streets and the houses of the attacked. (15th) During the epidemic the sale of all kinds of fruits was prohibited. (16th) In the stream; and private basins within the houses; only the well-to-do classes give their washing out. (17th) 28 days—ascend, 10; apogee, 4; descent, 14. (18th) No. (19th) No. (20th) 72 attacks—40 males, 32 females. (21st) 29 deaths—9 males, 20 females. (22d) Lower; to the north 27; to the south 45. (24th) Those who fled in the first period all escaped.

*Valdaracete, 1,233 inhabitants.*—(1st answer.) From the 13th of August to the 4th of September. (2d) By harvesters proceeding from Ciempozuelos. (3d) First good; second bad. (4th) There is none; inhabitants clean. (5th) Well and fountain water; good; containing magnesia. (6th) No. (7th) Calcareous; no fevers. (8th) At 8 meters. (9th) There is none. (10th) Equally. (11th) No rivers nor streams. (13th) By land. (14th) Disinfectants. (15th) Yes. (16th) In lavatories and streams. (17th) 23 days—ascend, 4; apogee, 6; descent, 13. (18th) No. (19th) Yes. (20th) 167 attacks—82 males, 85 females. (21st) 39 deaths—15 males, 24 females. (22d) All in the lower; to the north, 108; to the south, 59. (23d) There are none. (24th) The majority of the attacks were to the north, and the cemetery was also located on this side of the village.



*Fresno de Torote*, 412 inhabitants.—(1st answer.) From the 14th to the 27th of August. (2d) By persons. (3d) Both miserable. (4th) There is no kind of public cleaning. (5th) Public fountain of good quality. (6th) No. (7th) Clay; many marshes, and endemic fevers, which increase in autumn. (8th) At 230 meters. (9th) Of brick. (10th) Less than this last. (11th) Upon a small river called Torote. (12th) The attacked inhabited houses distant from the river, and near the marshes. (13th) Neighboring roads. (14th) Insufficient disinfectants. (15th) Yes. (16th) In the little river Torote. (17th) 14 days—irregular march. (18th) No. (19th) Yes. (20th) 5 attacks—3 males, 2 females. (21st) 3 deaths—3 males. (22d) All in the lower.

*Valdeavero*, 2,167 inhabitants.—(1st answer.) From the 5th to the 17th of September. (2d) Believed by persons. (3d) First good; second bad. (4th) No public cleaning of any kind; excrement in the court-yards. (5th) A covered spring; good. (6th) No. (7th) Siliceous clay; many marshes and endemic fevers, which double in frequency in autumn. (8th) At 270 meters. (9th) Of brick. (10th) Always have been light. (11th) Near a stream, which supplies the town with water. (12th) Equally. (13th) Neighboring roads. (14th) Disinfectants and insufficient fumigations. (15th) Yes. (16th) In streams and pools; also in tanks, whose waters are subsequently used for irrigation. (17th) 13 days—course unobserved. (18th) No. (19th) Yes. (20th) 5 attacks. (21st) 2 deaths. (22d) All in the lower. (23d) There are none.

*Belmonte de Tajo*, 1,030 inhabitants.—(1st answer.) From the 7th to the 17th of October. (2d) It is believed by persons. (3d) Good. (4th) There is none; cleaning by the municipality. (5th) Spring water; good, containing lime and magnesia. (6th) No. (7th) Calcareous; no marshes, nor fevers. (8th) At 250 meters. (9th) Of brick. (10th) More this time. (11th) There is neither river nor stream. (13th) By land. (14th) Disinfectants. (15th) Yes. (16th) In public lavatories and outside of the houses. (17th) 11 days—ascend, 2; apogee, 4; descent, 5. (18th) No; coincided with heat. (19th) Yes. (20th) 50 attacks—16 men, 28 women; 6 children. (21st) 16 deaths—6 men, 8 women, 2 children. (22d) All in the lower; to the north, 23; to the south, 27.

*Aranjuez*, 7,532 inhabitants.—(1st answer.) From the 16th of June to the 5th of August; during the epidemic only 5,500 inhabitants remained; the rest fled. (2d) By various persons coming from Murcia, among the workmen of the neighboring farms. (3d) Both very bad. (4th) There is none; there are drains in many of the houses; the night-soil goes into the court-yards. (5th) In the houses along the river; the water is taken from the Jarama, after its union with the Tajo; in the village the water is taken from fountains. (6th) It is suspected that water of the river Jarama was contaminated in passing by Ciempozuelos. (7th) Alluvial soil, very permeable; on account of difficult drainage the town is surrounded by marshes, and malarial fevers are very frequent. (9th) Of glazed brick, and in some points of iron; and then a paved cistern or vault. (10th) In former epidemics less than this. (11th) Upon the river Tajo, and Jarama. (12th) The bad hygienic conditions of some of the houses had more influence than the proximity of the rivers. (13th) Railways and highroads. (14th) Disinfectants and isolation at the beginning, which on account of the excess of mortality were useless. (15th) Abuse of alcoholic beverages; instead of being a preventive, this occasioned gastro-intestinal disturbances. (16th) In the rivers. (17th) 51 days—ascend, 15; apogee, 5; descent, 31. (18th) Yes. (19th) No. (20th) 1,671 attacks. (21st) 843 deaths—409 males, 434 females. (23d) In the cavalry quarters, situated in the center of the town, in bad hygienic conditions, among 520 persons, there were 74 attacks; whilst in the infantry quarters, situated outside of the town, and among wide promenades, there were only 28 attacks among 800 individuals.

#### PROVINCE OF GUADALAJARA.

*Estables*, 556 inhabitants.—(1st answer.) From the 23d of June to the 23d of August. (2d) Is thought by persons and effects. (3d) Both bad. (4th) There is none; deposits in the courts and in receptacles for excrement; no public cleaning. (5th) Good well-water, containing lime. (6th) No. (7th) Calcareous and clay; water abounds; no marshes nor fevers. (8th) Contiguous. (9th) There is none. (10th) In 1855, more. (11th) A stream, which is not permanent.

(12th) Equally. (13th) Highways. (14th) Disinfectants and isolation. (15th) No. (16th) In the pools. (17th) 31 days. (18th) Yes. (19th) Yes. (20th) 38 attacks—18 males, 20 females. (21st) 17 deaths—8 males, 9 females. (22d) All in the lower; to the north 14; to the south, 24.

*Mochales*, 618 inhabitants.—(1st answer.) From the 25th of July to the 18th of September. (2d) By inhabitants who were at Molina and other infected villages; Aragon. (3d) Both bad. (4th) There is none; inhabitants clean. (5th) Spring water; but the majority of the people use river water, containing lime. (6th) Used river water. (7th) Granite soil; no marshes, but intermittent fevers in spring. (8th) Contiguous. (9th) There is none. (10th) In 1855, less. (11th) Upon the banks of the river Mesa; the first case was 3 meters distant from it. (12th) In the neighborhood of the river, cemetery and fountain, there were 49 cases in twenty houses; development occurring in badly ventilated streets, there being no attack in the ward which was best ventilated. (13th) By land. (14th) Cleaning of the houses and streets, and disinfectants. (15th) Abuse of vegetables and salads. (16th) In the river and in a stream, the greater number; during the epidemic, a special lavatory supplied with running water was established for washing clothes of cholera patients. (17th) 55 days—ascend, 15; apogee, 10; descent, 30. (18th) There was an increase during the days of rain and storm, cases and deaths. (19th) Yes. (20th) 201 attacks—80 males, 121 females. (21) 78 deaths—31 males, 47 females. (22d) In the lower stories.

*Molina*, 3,084 inhabitants.—(1st answer.) From the 27th of July to the 10th of October. (2d) Imported. (3d) Both bad. (4th) There is none; the filth is thrown by the inhabitants into the lower part of the river. (5th) The river Gallo; good. (6th) No. (7th) Clay; sub-soil sandy; no marshes nor fevers. (8th) At 2 kilometers. (9th) There is none. (10th) In 1855 more. (11th) Upon the river Gallo. (12th) About two-thirds. (13th) Highways. (14th) Cordons, lazarettos, and disinfectants. (15th) Abuse of cucumbers and salads. (16th) In the river; by the families. (17th) 76 days. (18th) First case occurred with same. (19th) No. (20th) 746 attacks. (21st) 98 deaths—41 males, 57 females. (22d) Indifferently. (23d) In the post of the civil guards there were 5 deaths.

*Mazuecos*, 767 inhabitants.—(1st answer.) From the 27th of July to the 31st of August. (2d) It was believed by the drinking of water from a bad well. (3d) Very bad. (4th) There is none; no public cleaning. (5th) From the river Taja. (6th) Sulphate of lime; no marshes nor fevers. (8th) Within the village. (9th) There is none. (10th) Equally. (11th) Stream to the south supplied by a fountain 4 kilometers from the Taja. (12th) Equally. (13th) Neighboring roads and a highway. (14th) Disinfectants. (15th) No. (16th) In the Taja. (17th) 36 days—ascend, 13; apogee, 10; descent, 13. (18th) On the day of a storm first case occurred. (19th) Yes. (20th) 109 attacks—44 males, 65 females. (21st) 19 deaths—7 males, 12 females. (22d) All in the lower; equally to the north and south.

*Almonacid de Zorita*, 1,325 inhabitants.—(1st answer.) From the 27th of July to the 31st of August. (2d) Suspected by soiled clothing of some harvesters. (3d) First good; second very bad. (4th) There is none in court-yards; cleaning by the inhabitants. (5th) Spring water, containing lime. (6th) No. (7th) Clay; no marshes nor fevers. (8th) Near. (9th) Of brick. (10th) Much more this time; none in 1855. (11th) No. (13th) By land. (14th) General disinfection; inspection of travelers from infected places, and fumigation of baggage. (15th) Yes. (16th) In public lavatories. (17th) 36 days. (18th) No; descent, with abundant rain for two days. (19th) Yes. (20th) 76 attacks—26 males, 50 females. (21st) 20 deaths—3 males, 17 females. (22d) All in the lower.

#### PROVINCE OF TOLEDO.

*Toledo*, 20,176 inhabitants.—(1st answer.) From the 23d of June to the 30th of August. (2d) Imported second time from infected points within the same province. (3d) First bad; second worse; all of the poor class. (4th) Sewers only in the central portion of the city, discharging into the river; some large sewers empty near the point where the water supply of the capital is obtained; public cleaning defective. (5th) A small number use spring water;



the greater part use river water, which passes through very defective filters; there are also large earthen jars in some houses. (6th) Suspected. (7th) Soil decomposed granite; full of pebbles, diverting filtration and escape of water; there are some malarial fevers within the town during certain seasons of the year. (8th) Distant from the city. (9th) Of brick. (10th) Suffered more formerly. (11th) Upon the Tajo. (12th) In the lower part known as the Cobahuclas, a few cases; in the opposite part and upon the opposite shore of the river there was no case. (13th) Highways and railroads. (14th) In the epidemic of 1884, cordons and lazarettos; in that of 1885, disinfectants. (15th) Abuse of fruits and liquor. (16th) In the river. (17th) 68 days. (18th) No. (19th) No. (20th) About 200 attacks. (21st) 115 deaths. (22d) No notable difference, but in the houses of the poor lower stories were most invaded. (23d) In an asylum of the aged and in insane asylum greater number of attacks. (24th) There was only a semblance of a cordon, and there were some attacks outside of it.

*Villanueva de La Sagra*, 1,323 inhabitants.—(1st answer.) From the 16th of June to the 10th of August. (2d) Imported by some harvesters. (3d) Good. (4th) There is no public cleaning. (5th) Of the river Tajo. (6th) No. (7th) Clay; no marshes nor intermittent fevers. (8th) At 300 meters. (9th) There is a fountain with very little water which is not used; iron pipes. (10th) More; about 10 persons. (11th) Near the Tajo, at 3 kilometers to the north. (12th) The southern part less. (13th) Highways and railroads. (14th) Disinfectants in the houses of the attacked. (15th) Yes. (16th) In the river during the summer; generally in the houses. (17th) 55 days. (18th) Increased with storm. (19th) No. (20th) 149 attacks—97 males, 52 females. (21st) 17 deaths—8 males, 9 females. (22d) There are only lower stories.

*Santa Olalla*, 1,889 inhabitants.—(1st answer.) From the 29th of June to the 24th of August. (2d) By the use of water which passed by an infected place, where the inhabitants washed their clothing in it. (3d) Both bad, and the houses of the first attacked low-roofed near the stream. (4th) There is none; the filth runs in the gutters; no one charged with cleaning. (5th) Good, and obtained from springs containing more lime than magnesia. (6th) No. (7th) Clay, and is bordered by a stream; intermittent fevers frequent. (8th) Within the village. (9th) Iron. (10th) Equally. (11th) Situated in a valley. (12th) Equally. (13th) Highways and railroads. (14th) Disinfectants. (15th) Abuse of fruits, principally cantaloupes and watermelons. (16th) In the stream beyond the houses. (17th) 55 days—ascend, 12; apogee, 20; descent, 23. (18th) No. (19th) Yes. (20th) 155 attacks—57 males, 98 females. (21st) 45 deaths—12 males, 33 females. (22d) In the lower. (23d) There are none. (24th) Fumigations and disinfectants and good hygiene produced very good results.

*Ontígola*, 2,697 inhabitants.—(1st answer.) From the 28th of June to the 18th of July. (2d) By some harvesters from Cuenca. (3d) Good. (4th) There is none. (5th) Good spring water. (6th) No. (7th) Calcareous; at 3 kilometers there is a large marsh; the lake Ontígola; some fevers. (8th) At 40 meters. (9th) Of iron. (10th) Less this time. (11th) No. (13th) Highways and railways. (14th) Disinfectants. (15th) Yes. (16th) In the streams. (17th) 21 days—ascend, 2; apogee, 8; descent, 11. (18th) Yes; 4 days. (19th) Yes; 2 or 3 days before. (20th) 179 attacks—98 males, 81 females. (21st) 89 deaths—42 males, 47 females. (22d) All in the lower; to the south, 121; to the north, 158.

*Carpio de Tajo*, 3,053 inhabitants.—(1st answer.) From the 3d of July to the 3d of September. (2d) By a woman from Madrid. (3d) Both bad. (4th) There is none; the inhabitants clean. (5th) Good stream of water. (6th) No. (7th) Sandy; no marshes, but fevers in spring and more in autumn. (8th) In the center; after the epidemic; at 300 meters. (9th) There is none. (10th) Less this time. (11th) Upon a stream to the east; part near the stream suffered most; upwards of 60 persons. (13th) Railways and highways. (14th) Disinfectants. (15th) Use vegetables, cucumbers, and salads. (16th) In the stream. (17th) 63 days—ascend, 8; apogee, 18; descent, 37. (18th) Yes. (19th) Yes. (20th) 655 attacks—305 males, 350 females. (21st) 191 deaths—91 males, 100 females. (22d) In the upper stories.

*Romeral*, 2,008 inhabitants.—(1st answer.) From the 8th of July to the 3d of September. (2d) By persons from Aranjuez. (3d) Both good. (4th) There is none; filth deposited in the courts. (5th) Worse. (6th) No. (7th) Tertiary limestone; no marshes nor frequent inter-

mittent fevers. (8th) At 500 meters. (9th) There is none. (10th) This time, less. (11th) Distant from rivers and streams. (13th) By land. (14th) Cordons. (15th) Yes; cantaloupes, watermelons, tomatoes, and peppers. (16th) Generally in the houses; some beyond the village. (17th) 58 days—ascend, 29; apogee, 10; descent, 19. (18th) Not observed. (19th) No. (20th) 241 attacks—90 males, 151 females. (21st) 121 deaths—53 males, 68 females. (23d) All in the lower.

*Puente del Arzobispo*, 1,520 *inhabitants*.—(1st answer.) From the 12th of July to the 14th of August. (2d) It is observed that persons used the Tajo water. (3d) Both bad. (4th) No sewerage or public cleaning. (5th) Wells and springs good, containing lime. (6th) The first cases drank river water. (7th) Clay and limestone; no marshes; fevers generally in summer and beginning of autumn. (8th) At 40 meters. (9th) There is none. (10th) Twice greater in 1855. (11th) Upon the river Tajo, 150 meters, and upon a stream which is almost always dry. (12th) About 4 to 1. (13th) By land. (14th) Disinfectants. (15th) Yes; especially vegetables. (16th) In private basins, outside of the river and in the river. (17th) 33 days—ascend, 7; apogee, 16; descent, 10. (18th) Yes. (19th) Yes. (20th) 160 attacks. (21st) 60 deaths—25 males, 35 females. (22d) Majority in the lower and to the north.

*Cuerva*, 1,149 *inhabitants*.—(1st answer.) From the 20th of July to the 2d of September. (2d) By persons from Toledo and infected places. (3d) Both bad. (4th) There is none; the filth deposited in the court-yards and afterwards removed to the fields; cleaning by the inhabitants. (5th) Good spring water in wells and from a fountain of unknown source; that of the well contains lime; of the fountain, magnesia. (6th) No. (7th) Sandy and clay; no marshes nor fevers. (7th) At 1 kilometer. (9th) There is none. (10th) No epidemic. (11th) Between two streams at a distance of 200 meters. (12th) Equally. (13th) By land. (14th) Disinfectants. (15th) Abuse of fruits and vegetables. (16th) Clothes washed in well-water outside of village. (17th) 45 days—ascend, 22; apogee, 10; descent, 13. (18th) No. (19th) No. (20th) 85 attacks—43 males, 42 females. (21st) 25 deaths—12 males, 13 females. (22d) All in the lower; some to the south; others to the north. (23d) There is none.

*Quero*, 1,669 *inhabitants*.—(1st answer.) From the 10th of July to the 29th of August. (2d) Unknown. (3d) In general ordinary; swimming in excrement. (4th) There is none; some deposited on the soil; in special receptacles, and it serves for manure. (5th) Very good well-water. (6th) No. (7th) Calcareous; sandy and clay; there are two marshes at a considerable distance. (8th) At 1 kilometer. (9th) There is none. (10th) Less in 1855. (11th) No. (13th) Railways and highways. (14th) Lazarettos, cordons, and fumigations. (15th) Yes; watermelons, cantaloupes, cucumbers, and tomatoes. (16th) In the house. (17th) 50 days—ascend, 20; apogee, 12; descent, 18. (18th) Apogee coincided with storms. (20th) 203 attacks—77 males, 126 females. (21st) 59 deaths—21 males, 38 females. (22d) All the houses one story; situated to the north and south.

*Talavera de La Reina*, 10,029 *inhabitants*.—(1st answer.) From the 11th of July to the 2d of September. (2d) From infected places. (3d) First ordinary; second bad. (4th) There is none; there are sinks in the houses and the filth goes into the court-yards and to the river; cleaning by the municipality. (5th) Spring water collected in a good reservoir and distributed by pipes in good condition. (6th) The first cases used well-water; prohibition of this resulted well. (7th) Sandy clay; no marshes; in spring and autumn intermittents. (8th) At more than 1 kilometer. (9th) Iron pipes; in greater part of lead. (10th) Less this time. (11th) On the right bank of the Tajo, and at 5 to 6 kilometers; the river Alberche flows into it; on both sides of the village there are streams. (12th) The epidemic began in the part near the Tajo, but it did not spread from there. (13th) Railway and highway. (14th) Inspection, fumigations and disinfectants. (16th) In the lavatories of the neighboring villages or in the river Alberche and in springs. (17th) 53 days—ascend, 13; apogee, 16; descent, 24. (18th) The maximum on the third day after a great storm. (19th) Yes. (20th) 437 attacks—161 males, 276 females. (21st) 147 deaths—53 males, 94 females. (23d) No cases in the prison. (24th) Majority of the cases poor.

*Gálvez*, 2,941 *inhabitants*.—(1st answer.) From the 14th of July to the 21st of August. (2d) It is thought by infected persons from Carpio. (3d) Bad. (4th) There is none; depos-



ited in the court-yards; no public cleaning. (5) Spring water collected in a reservoir; wells, some containing sulphate of lime. (6th) Large number of wells. (7th) Clay; to the west granite and feldspathic rocks; no marshes, but fevers in autumn. (8th) At 600 meters. (9th) Of brick. (10th) This time more. (11th) A small distance from a stream. (12th) There is no river. (14th) Disinfectants and fumigations in the squares and streets. (15th) Abuse of fruits. (16th) Outside of houses; in the stream and in private basins. (17th) 36 days—ascend, 11; apogee, 4; descent, 21. (18th) Epidemic increased after a storm. (19th) No. (20th) 376 attacks—154 males, 222 females. (21st) 183 deaths. (22d) All in the lower; to the north, 222; to the south, 154. (24th) Majority of the victims were among the weak; the epidemic decreased notably after fumigations.

*Tembleque, 3,362 inhabitants.*—(1st answer.) From the 31st of July to the 18th of September. (2d) By persons from infected places. (3d) Both bad. (4th) There is none; the household water carried off by pipes conducting the rain-water from the court yards into the streets; cleaning by the municipality. (5th) Water contains nitrates, selenites, and proceeds from wells of unknown source; it is considered good. (6th) No. (7th) The village is situated in a hollow; clay soil; frequent formation of pools; intermittents appearing in autumn. (8th) 150 meters. (9th) There is none. (10th) Less this time than formerly. (11th) No rivers nor streams, but three lagoons are often formed after rains very near the village. (12th) In the present epidemic the part less attacked was precisely that near the point where the rain-water collects. (13th) Railways and highways. (14th) Cordons, lazarettos, disinfectants; careful cleaning of the streets, also of the houses. (15th) No. (16th) Not customary to wash the clothes outside the houses. (17th) 50 days—ascend, 21; apogee, 9; descent, 20. (18th) No. (19th) Yes. (20th) 456 attacks—191 males, 265 females. (21st) 121 deaths—47 males, 84 females. (22d) 2 attacks in the upper, 454 in the lower; to the north, 80; to the south, 110; to the east, 120; to the west, 146. (23d) In the post of the civil guard, the establishment in which there was a conglomeration of persons, the mortality was not relatively greater than in the village. (24th) The miserable location of the present cemetery makes it necessary to construct a new one, but this has not been done for want of funds.

*Calera, 3,073 inhabitants.*—(1st answer.) From the 16th of July to the 3d of August. (2d) It is believed by person from infected place. (3d) Good. (4th) There is none; in places for the collection of manure; excrement at 200 meters; cleaning by the inhabitants. (5th) Good, pleasant, hard spring water, containing little lime and magnesia. (6th) No. (7th) Calcareous and clay; no marshes nor fevers. (8th) At 600 meters. (9th) Of brick. (10th) Equal to that of 1855. (11th) At 5 kilometers from the Tajo. (13th) Railways and highways. (14th) Disinfection and isolation. (15th) Abstained during the epidemic. (16th) In the streams. (17th) 49 days—ascend of 15 days, up to the 20th of July. (18th) Increased after a storm. (19th) Yes. (20th) 132 attacks—36 males, 96 females. (21st) 48 deaths—18 males, 30 females.. (22d) All in the lower.

*Cabezamesada, 887 inhabitants.*—(1st answer.) From the 18th of July to the 30th of August. (2d) By effects and persons from infected places. (3d) Both bad. (4th) There is none; cleaning of the courts and the streets abandoned. (5th) Good well water, agreeable, hard, containing sulphate of lime and magnesia. (6th) No. (7th) Clay; no marshes; frequent fevers. (8th) Within the village. (9th) There is none. (10th) This time more. (11th) At 200 meters from the river Riancares. (12th) More than in the part next the river. (13th) By land. (14th) Disinfectants. (15th) Abuse of cantaleups, watermelons, tomatoes, and cucumbers. (16th) In the river and in the houses; generally given out to wash. (17th) 43 days—ascend, 10; apogee, 8; descent, 25. (18th) Yes. (19th) Yes. (20th) 175 attacks—89 males, 86 females. (21st) 56 deaths. (22d) There are no upper stories; greater part to the north. (24th) The cases were in caves.

*Mora, 7,219 inhabitants.*—(1st answer.) From the 27th of July to the 6th of September. (2d) It is thought by persons. (3d) First good; second bad. (4th) There is none; deposits in court yards. (5th) Well and spring water; disagreeable and containing much lime. (6th) No. (7th) Sandy calcareous and clay; no marshes; much fever in spring and autumn. (8th) At 1,000 meters to the north. (9th) There is none. (10th) Less this time. (11th) Upon a

rocky glen; the streets are converted into streams. (13th) By rail and highway. (14th) Disinfectants. (15th) No. (16th) Casks in the houses; they are removed when full. (17th) 41 days. (18th) Descent from the 24th to the 28th August, after rain. (19th) Yes. (20th) 225 attacks—118 males, 107 females. (21st) 99 deaths—43 males, 56 females. (22d) All in the lower; to the north, 41; to the south, 85.

*La Puebla de Almoradiel*, 2,878 inhabitants.—(1st answer.) From the 29th of July to the 21st of September. (2d) By persons from infected places. (3d) First good; second bad. (4th) There is none; the proprietors at different times do the cleaning; usually the cleaning is done by the municipality. (5th) Well water; fair; containing lime. (6th) No. (7th) Calcareous and clay; no marshes; fevers in autumn. (8th) Adjoining the village. (9th) There is none. (10th) More this time. (11th) At 10 meters above the river Gimel; at 1 kilometer from the village. (12th) Equally. (13th) By land. (14th) Disinfectants; cordons and lazarettos. (15th) Abuse of fruits and vegetables. (16th) In basins within houses. (17th) 54 days—ascend, 12; apogee, 8; descent, 34. (18th) No; majority with rains. (19th) Yes. (20th) 163 attacks—58 males, 105 females. (22d) All in the lower.

*Puebla De D. Fadrique*, 2,720 inhabitants.—(1st answer.) From August 22d to September 26th. (2d) By harvesters. (3d) First good; second bad. (4th) There is none; filth deposited in the houses; no public cleaning. (5th) Wells outside of the village; pleasant, good, containing magnesia. (6th) No. (7th) Calcareous, sandy; water found at  $2\frac{1}{2}$  meters depth; no marshes; some intermittents in spring. (8th) 150 meters to the north. (9th) There is none. (10th) Equally. (11th) Between two rivers which surround it at 6 kilometers distant. (13th) By land. (14th) Disinfectants. (15th) Abuse of fruits. (16th) Each one in the houses. (17th) 36 days—ascend, 10; apogee, 4; descent 22. (18th) Yes. (19th) Yes. (20th) 219 attacks—86 males, 133 females. (21st) 51 deaths—22 males, 29 females. (22d) Unknown.

*Consuegra*, 6,811 inhabitants.—(1st answer.) From August 12th to September 15th. (2d) By persons from infected places, and by the use of clothing of cholera patients. (3d) First good; second bad. (4th) There is none; filth collected in special receptacles; cleaning by the municipality. (5th) Springs, wells, and fountains; good, containing lime and magnesia. (6th) No. (7th) Calcareous; no marshes; fevers especially in autumn. (8th) Two contiguous to the village. (9th) No. (10th) One more; the other less. (11th) Divided by an unhealthy stream. (12th) More in the streets near the stream. (13th) Highways. (14th) Cordons and lazarettos. (16th) Yes; cantaleups, tomatoes, and watermelons. (16th) In streams or in basins within the houses. (17th) 35 days—ascend, 15; apogee, 7; descent, 13. (18th) No. (19th) Not observed. (20th) 380 attacks—108 males, 272 females. (21st) 137 deaths—48 males, 89 females. (22d) All of the houses have lower stories.

*Novés*, 2,271 inhabitants.—(1st answer.) From August 30th to September 17th. (2d) Unknown. (3d) First ordinary; second bad. (4th) Stream which runs through the village receives the sewerage; cleaning by the inhabitants. (5th) Good spring water; pleasant, containing magnesia. (6th) No. (7th) Sandy clay; no marshes; fevers in autumn. (8th) At the side of the village. (9th) Of brick. (10th) In 1855 more. (11th) Traversed by a stream containing little water. (12th) The only part of the village which suffered was higher than that on the left bank of the stream. (13th) By land. (14th) Hygiene and disinfectants. (15th) Yes; especially watermelons, peppers, and tomatoes. (16th) In distant streams; washing given out. (17th) 19 days. (18th) Coincided with good weather. (19th) No. (20th) 27 attacks—13 males, 14 females. (21st) 18 deaths—11 males, 7 females. (22d) All in the lower.

*Totanés*.—(1st answer.) From the 2d of August to the 4th of September. (2d) By persons from infected places. (3d) Both ordinary. (4th) There is none; cleaning by the inhabitants, supervised by the board of health. (5th) Spring water, pleasant, containing magnesia. (6th) Unknown, but believed not. (7th) Clay; betrayed by a stream which causes some intermittent fever in autumn. (8th) At 500 meters. (9th) There is none. (10th) The former more without noting why. (11th) Situated upon a plain above the confluence of two streams. (12th) Equally. (13th) By land. (14th) Isolation and disinfectants. (15th) Little fruits, especially during the epidemic. (16th) In streams and in private basins. (17th) 33 days—



ascent, 8; apogee, 8; descent, 17. (18th) No. (19th) Yes. (20th) 31 attacks—14 males, 17 females. (21st) 14 death—6 males, 8 females. (22d) All in the lower. (23d) There are none.

*Villaminaya*, 680 inhabitants.—(1st answer.) From the 17th of August to the 9th of September. (2d) Unknown. (3d) First ordinary; second bad. (4th) There is none; filth deposited, in the houses; no public cleaning. (5th) Ordinary spring water containing lime. (6th) No. (7th) Strata of sand and one of clay; no marshes nor fevers. (8th) Within the village. (9th) There is none. (10th) Equally. (11th) To the east there is a river, to the west a well. (12th) The lowest part 7 per cent. more than the upper. (13th) By land. (14th) Disinfectants. (15th) Yes. (16th) In public lavatories; they also wash the clothing of other villages. (17th) 23 days—ascend, 14; apogee, 3; descent, 6. (18th) No. (19th) Yes; houses all in village. (20th) 29 attacks—16 males, 13 females. (21st) 26 deaths—8 males, 18 females. (22d) All in the lower; to the north and south.

*Orgáz*, 2,697 inhabitants.—(1st answer.) From the 20th of August to the 29th of September. (2d) Imported by persons. (3d) Both good. (4th) There is none; excrement used for manure; cleaning by the inhabitants and the municipality. (5th) Wells and fountains excellent; well-water prohibited during the epidemic. (7th) Sandy; granite, clay, and limestone; no marshes; intermittent fevers in spring and autumn. (8th) Adjoining to the south. (9th) Of brick. (10th) Formerly more. (11th) Upon a stream which stagnates; during the epidemic it was cleaned. (13th) By land. (14th) Cleanliness; fumigations with sulphur disinfections and burning clothing. (15th) During the epidemic; no. (16th) In basins; during the epidemic disinfected by chloride of lime. (17th) 40 days. (18th) Not observed. (19th) Yes. (20th) 16 attacks. (21st) 6 deaths—2 males, 4 females. (22d) All lower. (23d) No attack in post of civil guard.

*Pantoja*, 436 inhabitants.—(1st answer.) From the 12th of July to the 18th of September. (2d) Believed by clothing from infected places. (3d) Both good. (4th) There is none; the filth is not collected; cleaning by the inhabitants. (5th) Good and pleasant spring water. (6th) No. (7th) Declivity to the north and south; clay, no marshes; fevers in autumn. (8th) 500 meters to the north. (9th) Of lead. (10th) Unknown before. (11th) The Tajo is about 11 kilometers; the stream Guadalen at 2 kilometers. (12th) Equally. (13th) By land and rail. (14th) Disinfectants. (15th) Yes; cantaloupes, watermelons, and grapes. (16th) In public lavatories. (17th) 69 days—ascend, 29; apogee, 6; descent, 34. (18th) Increased with storms. (19th) Yes. (20th) 40 attacks—16 males, 24 females. (21st) 16 deaths—10 males, 6 females. (22d) All in the lower; to the north, 16; to the south, 22. (24th) The majority badly fed.

*Pulgar*, 781 inhabitants.—(1st answer.) From the 19th of August to the 20th of September. (2d) Spontaneous. (3d) Both bad. (4th) There is none; inhabitants clean. (5th) Well and spring water; good, pleasant, and hard. (6th) No. (7th) By sand and granite; no marshes; fevers in summer. (8th) Near the village. (9th) There is none. (10th) Much more in 1860. (11th) At the confluence of two streams. (12th) Equally. (13th) By land. (14th) Disinfectants. (15th) Yes; cantaloupes, watermelons, and vegetables. (16th) In pools outside the village; in streams and in houses. (17th) 33 days—ascend, 14; apogee, 4; descent 15. (19th) Yes. (20th) 51 attacks. (21st) 10 deaths—5 males, 5 females. (22d) There are no upper stories.

*Polán*, 1,802 inhabitants.—(1st answer.) From the 22d of August; ended on same day. (2d) By washing coming from infected places. (3d) Good. (4th) There is none; deposited in courts; cleaning by the municipality. (5th) Good, pleasant spring water. (6th) No. (7th) Clay; there are no marshes; some fevers in summer. (8th) At 600 meters. (9th) Of brick. (10th) More in 1855. (11th) Traversed by a stream. (13th) By land. (14th) Disinfectants. (15th) Fruits and vegetables. (16th) In public lavatories and in streams. (17th) One day. (18th) No. (19th) No. (20th) 2 attacks—1 male, 1 female. (21st) 2 deaths—1 male, 1 female. (22d) To the lower and to the south.

*Esquivias*, 1,409 inhabitants.—(1st answer.) From the 24th of August to the 2d of October. (2d) Unknown. (3d) Good. (4th) There is none; deposited in receptacles which are emptied at a fixed time in the year to serve for manure. (5th) Springs; ordinary quality, some hard,

containing considerable sulphate of lime and magnesia. (6th) It is thought yes. (7th) In greater part clay; no marshes; fevers which are always prevalent are always imported. (8th) At 500 meters to the southwest. (9th) Of brick. (10th) The former less. (11th) No streams nor river. (12th) The higher and eastern portion of the town most attacked. (13th) By land. (14th) Disinfectants, such as chlorides of lime and isolation of families. (15th) Abuse of fruits and vegetables very frequent. (16th) In a public lavatory, very small in proportion to the size of the town. (17th) 40 days. (18th) Unobserved. (19th) Yes. (20th) 19 attacks. (21st) 11 deaths. (22d) Majority to the south and to the east; all in the lower stories. (23d) There are none. (24th) Bad food and disobedience to hygienic rules were the cause of the epidemic.

## PROVINCE OF LÉRIDA.

*Lérída*, 18,377 inhabitants.—(1st answer.) From the 2d of July to the 19th of October. (2d) Imported by an employé of the railway company from Zaragoza, who died. (3d) Both bad. (4th) Sewers only in the principal streets; none in the poor quarters, where the night-soil is deposited in small receptacles and in the streets; no public cleaning. (5th) From a canal, derived from the river Ribagarzana and a confluent of the Segre. (6th) No; for the villages up stream were subsequently invaded. (7th) Situated on a high hill; clay soil; walls are washed by the river Segre; the houses and streets are narrow and tortuous; houses high and well built, but are damp and without ventilation. (9th) Lead pipes. (10th) Same as former. (11th) Upon the river Segre; upon a canal and at the foot of a hill. (12th) The upper part inhabited by laboring classes suffered most, although the epidemic began in the lower part inhabited by the well-to-do class. (13th) Roads and railways. (14th) No preventive measures; after the development some disinfectants within the houses and streets. (15th) Yes; of every kind. (16th) Clothing washed in the river. (17th) 110 days—ascend, 40; apogee, 12; descent, 58. (18th) No. (19th) Unknown. (20th) 2,065 attacks. (21st) 541 deaths. (23d) In the garrison and in the prison attacks were scarce; good food contributed to this. (24th) The epidemic followed along the river Segre, ascending it; the capital being invaded almost the last.

*Balaguer*, 4,742 inhabitants.—(1st answer.) From the 9th of September to the 10th of October. (2d) By persons from Lérída. (3d) First good; second bad. (4th) Sewers in the square and in three streets only; night-soil into the court-yards; cleaning by the municipality. (5th) From the river Segre; generally supplied by fountains, the water being filtered from the river; good. (6th) No. (7th) Alluvium and sandy clay, calcareous; no marshes nor intermittent fevers. (8th) Near and above the village. (9th) A covered canal. (10th) That of 1854 much more. (11th) Bathed by the river Segura. (12th) Very little; the rich inhabited the upper part. (13th) Highways and neighboring roads. (14th) Fumigation of strangers; cleanliness; disinfectants in sewers; drying of the court-yards and pools and fumes of sulphur. (15th) Yes, much. (16th) In private lavatories and in the river. (17th) 32 days—ascend, 8; apogee, 5; descent, 20. (18th) No. (19th) Yes. (20th) 40 attacks—21 males, 19 females. (22d) 21 in the lower, 20 in the upper; to the north, 21; to the south, 2. (23d) No attacks in the prison.

*Bellvis*, 1,517 inhabitants.—(1st answer.) From the 18th of September to the 8th of October. (2d) By persons. (3d) First bad; second good; there are two ponds which are empty at times. (4th) There is none; inhabitants clean. (5th) Use water from the river Segre. (6th) Yes; emanations from the pool. (7th) Good; clay and limestone; pools; fevers frequent in autumn. (8th) At 500 meters. (9th) There is none; canals conduct the water. (10th) The anterior did not assume the malarial type. (11th) At the confluence of a river and the Urgel Canal, which passed by it. (12th) About 80 per cent. (13th) Neighboring roads. (14th) Disinfectants. (15th) No. (16th) In the streams and canals. (17th) 20 days—ascend, 5; apogee, 5; descent, 10. (18th) Yes; a few hours after rain the mortality increased. (19th) No. (20th) 23 attacks—10 men, 11 women, 1 boy, 1 girl. (21st) 12 deaths—7 males, 5 females. (23d) All in the lower; to the north, 21; to the south, 2.



*Villa de Liñola, 759 inhabitants.*—(1st answer.) From the 19th of September to the 2d of October. (2d) By persons. (3d) Both bad. (4th) There is none; there is no public cleaning. (5th) The majority from the canal proceeding from the Segre; that of pools is bad. (6th) No. (7th) Many ponds; many and various fevers. (8th) The old outside of the wall; the new at 720 meters. (9th) There is none. (10th) No data. (11th) There is no river, but there are canals and the above-mentioned ponds. (12th) Some in the lower part, near the canals. (13th) Highways and pathways. (14th) Disinfectants and fumigations. (15th) Yes. (16th) In canals. (17th) 13 days—ascend, 5; apogee, 3; descent, 5. (18th) Yes. (19th) Yes. (20th) 14 attacks—7 males, 7 females. (21st) 13 deaths—7 males, 6 females. (22d) 12 in the upper, 2 in the lower. (23d) There are none.

*Alguaire, 2,165 inhabitants.*—(1st answer.) From the 15th of August to the 10th of September. (2d) By persons from infected places. (3d) Both bad. (4th) There is none; deposits in court-yards; no public cleaning. (5th) From canals proceeding from the river. (6th) No. (7th) Clay; no marshes nor fevers. (8th) At 500 meters. (9th) There is none. (10th) More this time. (11th) No. (13th) By land. (14th) Disinfectants. (15th) Very much of all. (16th) In public lavatories. (17th) 26 days—ascend, 15; apogee, 6; descent, 5. (18th) No. (19th) Yes. (20th) 18 attacks—8 males, 10 females. (21st) 14 deaths—6 males, 8 females. (22d) All in the lower.

#### PROVINCE OF LOGROÑO.

*Rincón de Soto, 1,455 inhabitants.*—(1st answer.) From the 24th of July to the 28th of September. (2d) Unknown. (3d) Good. (4th) There is none; the inhabitants remove the dirt to the fields. (5th) From the Abro or from a well, which contains lime. (6th) No. (7th) Clay, and some limestone; no marshes; few fevers in autumn. (8th) At 100 meters. (9th) There is none. (10th) That of 1833 equal to this; in 1855, less. (11th) Between the Abro and an irrigation canal leading from the same. (12th) Equally. (13th) Railway and highway. (14th) Cordons and disinfectants. (15th) Abuse of fruits and vegetables. (16th) In canal and houses. (17th) 67 days—ascend, 28; apogee, 11; descent, 28. (18th) No. (19th) No. (20th) 457 attacks—165 males, 292 females. (21st) 77 deaths—42 males, 35 females. (24th) The attacked used vegetable food.

*Alcanadre, 1,409 inhabitants.*—(1st answer.) From the 26th of July to the 20th of September. (2d) Unknown. (3d) The first very ordinary; the houses of the first attacked very bad. (4th) There is none; the inhabitants clean by order of the mayor. (5th) From the river Abro. (6th) Unknown. (7th) Clay; there is a distant marsh; there are some fevers in summer and autumn. (8th) At 400 meters. (9th) There is none; the water of the river Abro is drawn by horse. (10th) Equally. (11th) Upon the river Abro, which is half a kilometer distant. (12th) Equally. (13th) Railway and the river Abro. (14th) All at times. (15th) Abuse of fruit and vegetables in great abundance. (16th) In the river Abro; in public lavatories, whose water proceeds from the side of the river. (17th) Upwards of 56 days—ascend, 19; apogee, 10; descent, 27. (18th) The greater mortality was noted in days of storms, and the development of the epidemic took place 20 days after the storm. (19th) Yes. (20th) Upwards of 250 attacks; predominant among the women more than among the men, and from the age of 20 to 70. (21st) 46 deaths—29 males, 17 females. (22d) Equally. (23d) There are none.

*San Vicente de la Sonsierra, 2,182 inhabitants.*—(1st answer.) From the 5th of August to the 31st of August. (2d) It is believed by effects proceeding from infected places. (3d) First good; second bad. (4th) There is none; the inhabitants clean. (5th) Good spring water. (6th) No. (7th) Sandy and tertiary sandstone; no marshes nor fevers. (8th) At 700 meters. (9th) Of iron. (10th) This time more. (11th) On the left of the Abro. (12th) Equally. (13th) By land and rail. (14th) Disinfections and fumigations. (15th) Abuse of fruits prohibited. (16th) Public lavatories and the river; washing in the Abro prohibited. (17th) 26 days. (18th) No. (19th) Yes. (20th) 200 attacks—83 males, 117 females. (21st) 41 deaths—15 males, 26 females. (22d) Equally. (24th) Those who disregarded hygienic rules were attacked.

*Galbarruli*, 241 inhabitants.—(1st answer.) On the 15th of August there was a case followed by death; on the 26th of the same month another followed also by death. (2d) It is believed that the first case was not imported, since the lady who died had not been out of the village, but it is thought that the second was imported from Miranda de Ebro. (3d) Both good. (4th) There is none; cleaning by the inhabitants under orders of the municipality. (5th) Spring water containing some nitrogen; pleasant. (6th) No. (7th) On high, although sandy, soil; no marshes nor intermittent fevers. (8th) Within the village; a new one is being built. (9th) Of brick. (10th) This time more. (11th) On healthy soil supplied with water from a single fountain. (13th) By land. (14th) Everything; by good hygiene. (15th) There is none. (16th) In public lavatories; under good hygienic conditions, for they are built of stone and cement, and have the necessary drains. (17th) One day for each case. (19th) Yes. (20th) 2 attacks—females. (21st) 2 deaths—females. (22d) Both in the upper stories and to the north.

*Driñas*, 448 inhabitants.—(1st answer.) From the 8th to the 13th of September. (2d) Unknown. (3d) Good. (4th) There is none; night-soil accumulates in the squares; cleaning by the municipality. (5th) From two fountains, and from the river Ebro; the first hard, the second soft, containing magnesia. (6th) No. (7th) Sandy; no marshes nor fevers. (8th) At 200 meters. (9th) Brick and stone. (10th) This time more. (11th) Upon the Ebro. (12th) Upper part suffered most. (13th) By land. (14th) Disinfectants. (15th) Abuse of fruits and vegetables. (16th) In the river, but prohibited before the epidemic. (17th) 6 days. (18th) No. (20th) 24 attacks—8 males, 16 females. (21st) 5 deaths—3 males, 2 females. (22d) All in the upper; to the north, 12; to the south, 12.

*Ollauri*, 805 inhabitants.—(1st answer.) From the 19th of September to the 11th of October. (2d) Attributed to the atmosphere being impregnated with pestilential causes, and to the existence of the disease in a distant village, three-quarters of an hour, and communication between the inhabitants of both villages. (3d) The location good; the houses of the attacked were in good condition, although that of the first case was cleaned, for it had a bad odor. (4th) No sewage; the river and the streams which traversed the village emptied into others which surround it, and they serve as sewers; the cleaning is done by the municipality. (5th) Some fountains and springs; there is a fountain in the center of the town supplied by an abundant spring through an iron pipe, and in part through pipes of iron and brick. (6th) No. (7th) Sandy; no marshes nor fevers. (8th) At 100 meters. (9th) Of brick and iron. (10th) This time less. (11th) At the confluence of streams or river with other streams which pass by the town. (12th) The disease was propagated from two houses in good condition in a well-ventilated street, which led to the river Molina. (13th) By land. (14th) Disinfectants. (15th) Abuse of fruits and peppers. (16th) Public lavatories; all the houses. (17th) 23 days. (18th) Coinciding with cold and clouds, accompanied by fogs; the epidemic began and it increased with coldness and dampness of the atmosphere. (19th) Yes. (20th) 73 attacks—29 males, 44 females. (21st) 20 deaths—3 males, 17 females. (22d) Attacks in the lower 65; in the upper 8; 13 to the north; 21 in houses to the south; 14 to the east; 26 to the west. (23d) There are none. (24th) Enteritis exists in the autumn and winter; on account of using iron and sulphate of lime they suffered from diarrhœa and disturbance of the digestive apparatus.

*Tudelilla*, 944 inhabitants.—(1st answer.) From the 25th to the 28th of September. (2d) Unknown. (3d) First good; second bad. (4th) There is none; inhabitants clean. (5th) From the river; although there are springs the inhabitants do not use them because of the existence of the river proceeding from the Hoz Mountain, with excellent water. (6th) No. (7th) Calcareous and clay; good hygienic conditions. (8th) At 200 meters. (9th) There is none. (10th) This time less. (11th) A considerable distance to the north is the river Molina, called also the Yasa; the water is scarce, and in summer there is hardly any flow for the consumption of the inhabitants. (13th) By land. (14th) Cordons, lazarettos, and disinfectants. (15th) Abuse of fruits and vegetables. (16th) Outside of houses. (17th) 3 days. (18th) Yes. (19th) Yes. (20th) 7 attacks—3 males, 4 females. (21st) 2 deaths. (22d) Equally.



## PROVINCE OF ÁLAVA.

*Nanclares de La Oca*, 540 *inhabitants*.—(1st answer.) From the 27th of July to the 28th of August. (2d) It is supposed imported by a soldier from Madrid, who died on arrival, as also his father on the following day. (3d) First good; second bad. (4th) There is none; no public cleaning. (5th) Spring water coming from a rock; its original source unknown; good quality, containing lime. (6th) No. (7th) Upon a declivity overlooked by a mountain to the north; the soil is rocky; no marshes or fevers. (8th) At 80 meters from the village. (9th) There is none. (10th) This time more. (11th) Upon the river Zadorra, and besides this it is traversed by a stream formed by running water from the mountain. (12th) Equally except in the lazaretto. (13th) Railway and highways. (14th) A lazaretto was established. (15th) Much use of cucumbers and peppers. (16th) In lavatories supplied by fountain water and by the rains. (17th) 32 days—ascend, 17; apogee, 5; descent, 10. (18th) On a day following a storm the first case occurred, and the same month there was a series of storms. (19th) No. (20th) Only 37 attacks officially declared. (21st) 24 deaths—9 males, 15 females. (22d) All in the upper and to the south. (23d) In the post of the civil guard a single death occurred. (24th) It is worthy of mention that the house is very rare in which no case has occurred, and that there was no genuine focus of infection.

*Ocio*, 934 *inhabitants*.—(1st answer.) From the 19th of August to the 11th of September. (2d) Imported from infected place. (3d) Both bad. (4th) There is none; the inhabitants clean. (5th) From the river which traversed the village, containing organic substances. (6th) Yes. (7th) Sandy; traversed by small river; no fevers. (8th) At 300 meters. (9th) There is none. (10th) This time less. (11th) Situated upon a river which traversed it. (12th) The deaths in the lower part at 3 meters above the level of the river. (13th) By land. (15th) No abuse of fruits. (16th) In the river. (17th) 23 days—ascend, 8; apogee, 6; descent, 9. (18th) No. (19th) No. (20th) 24 attacks. (21st) 4 deaths. (22d) All in the upper and equally to the north and south. (23d) There are none.

*Oyón*, 934 *inhabitants*.—(1st answer.) From the 30th of August to the 19th of September. (2d) Unknown. (3d) Ordinary. (4th) There is none; inhabitants clean. (5th) Good spring water, hard and containing salts of lime and magnesia. (6th) No. (7th) Sandy clay; some pools around the village, and pools of dung; intermittent fevers rare. (8th) At 200 meters. (9th) An open conduit. (10th) This time much more. (11th) To the left of a small river. (12th) Equally. (13th) By land. (14th) A cordon and disinfectants, but incomplete. (15th) Abuse of fruits and vegetables. (16th) In a small river. (17th) 21 days—ascend, 2; apogee, 4; descent, 15. (18th) Yes. (19th) Yes. (20th) 162 attacks—74 males, 88 females. (21st) 47 deaths—24 males, 23 females. (22d) Equally in the upper and lower stories. (23d) There are none. (24th) In the latter week of July there were heavy rains preceding destruction in the fields, leaving many animals dead; from their putrefaction diarrhœas appeared before the cholera and their stench from August 28 loaded the atmosphere.

*Mazeda*, 655 *inhabitants*.—(1st answer.) From the 14th to the 26th of September. (2d) Imported from an infected place. (3d) First ordinary; second bad. (4th) There is none; filth into the court-yards; during the epidemic carried beyond the village by a director. (5th) Good spring water upon the banks of a river, containing lime. (6th) No. (7th) Sandy clay; no marshes nor intermittent fevers. (8th) At 200 meters. (9th) Conduits of stone. (10th) This time less. (11th) Upon two small rivers. (12th) Equally. (13th) By land. (14th) Disinfectants and lazarettos. (15th) No abuse of fruits. (16th) In small rivers. (17th) 12 days—ascend, 2; apogee, 3; descent, 7. (18th) No. (19th) Yes. (20th) 7 attacks—4 males, 3 females. (21st) 3 deaths—2 males, 1 female. (22d) Upper stories to the south, 1; to the east, 3.

*Baños de Ebro*, 382 *inhabitants*.—(1st answer.) From the 1st to the 14th of September. (2d) By a person from an infected place. (3d) Both bad. (4th) There is none; cleaning by the inhabitants. (5th) Bad; from the Abro, containing sewerage, especially during times of rain. (6th) At the commencement used the river water, which was contaminated; afterwards this was replaced by other water of good quality; this change coinciding with the descent of the epidemic. (7th) Clay; no marshes nor frequent intermittent fevers. (8th) Adjoining the village. (9th)

There is none. (10th) In 1834 and this time more than in 1856. (11th) Upon the river Abro and its confluent, Linares, which flows at a little distance. (12th) Those near the river suffered most. (13th) By land. (14th) Fumigation. (15th) Abuse of fruit. (16th) Majority in the lavatory, whose water, impregnated with sewerage, flows into a stream which traversed the village and its courts; the water is used for drinking, especially by children. (17th) 13 days—ascend, 4; apogee, 3; descent, 6. (18th) Yes. (19th) Yes. (20th) 134 attacks—75 males, 59 females. (21st) 49 deaths—21 males, 28 females. (22d) Equally, and to the south. (23d) There are none. (24th) Asphyxic form was observed to predominate in fatal cases.

*Barriobusto, 377 inhabitants.*—(1st answer.) From the 5th of September to the 3d of October. (2d) By persons from infected places. (3d) Both bad. (4th) There is none; the night-soil mixed with straw and at once deposited in special receptacles; cleaning by the inhabitants. (5th) Good spring water containing lime. (6th) No. (7th) Clay; subterranean pools; no intermittent fevers. (8th) At 500 to 600 meters. (9th) Of brick. (10th) This time more. (11th) The river runs through the middle of the village; ordinarily dry during the summer. (12th) Two-thirds more than in the upper districts. (13th) By land. (14th) Lazarettos and disinfectants. (15th) Abuse of fruits. (16th) Public lavatories; each house washes its own. (17th) 29 days—ascend, 10; apogee, 5; descent, 14. (18th) No. (19th) Yes. (20th) 69 attacks—28 males, 41 females. (21st) 25 deaths—12 males, 13 females. (22d) In the upper stories. (23d) There are none.

*Salcedo, 753 inhabitants.*—(1st answer.) From the 6th to the 13th of September. (2d) Unknown. (3d) Both good. (4th) There are none; cleaning by inhabitants. (5th) Good and proceeding immediately from the mountain. (6th) No. (7th) Granite; no intermittents. (8th) At 600 meters. (9th) There is none. (10th) Equally. (11th) No river nor streams. (12th) Equally. (13th) By land. (14th) Isolation. (15th) No abuse of fruits or vegetables. (16th) In public lavatory; outside of houses. (17th) 8 days. (18th) No. (19th) No. (20th) 3 attacks—females. (21st) 2 deaths—females. (22d) In the upper stories. (23d) There are none.

*Moreda, 565 inhabitants.*—(1st answer.) From the 14th to the 26th of September. (2d) Imported. (3d) Both miserable. (4th) There is none; filth into the court-yards and squares; cleaning by contract. (5th) Good spring water; situated on the bank of the river. (6th) No. (7th) Clay; no marshes nor fevers. (8th) At 800 meters. (9th) Conduit of stone. (10th) The three former benign. (11th) Between two small rivers. (12th) Indifferently. (13th) Highways. (14th) Disinfectants, fumigations, and medical inspection. (15th) Abstention during the epidemic. (16th) In the rivers. (17th) 13 days—ascend, 2; apogee, 3; descent, 8. (18th) There was neither storm nor rain. (19th) Very frequent. (20th) 7 attacks. (21st) 4 deaths. (22d) In the upper.

#### PROVINCE OF TARRAGONA.

*Gargía, 1,626 inhabitants.*—(1st answer.) From the 2d of July to the 9th of September. (2d) First attack was in a person from the province of Valencia, the second in another from Zaragoza, where malaria existed and it was a fulminant case. (3d) Both bad. (4th) There is none; cleaning by the inhabitants. (5th) Use well-water. (6th) Not observed. (7th) Fevers frequent. (8th) Contiguous. (9th) There is none. (10th) This time more. (11th) On the left bank of the Abro. (12th) More attacks in the center than at the edges of the village. (13th) By the river and neighboring roads. (14th) Cleaning of the town and disinfectants. (15th) Abuse of fruits and vegetables. (16th) In the river. (17th) 69 days—ascend, 20; apogee, 3; descent, rapid; there being isolated cases in the following month. (18th) Not observed. (19th) Yes. (20th) 105 attacks—47 males, 58 females. (21st) 31 deaths—11 males, 20 females. (22d) Not observed. (23d) There are none.

*La Galera, 412 inhabitants.*—(1st answer.) From the 5th of July to the 15th of August. (2d) By persons from infected places. (3d) Houses of those first attacked bad. (4th) There is none; cleaning by the municipality. (5th) Well-water of unknown origin; good, hard, agreeable. (6th) No. (7th) Sandy; no marshes; pool in the center of the town for watering the cattle; this was closed by order of the authorities at the appearance of the first cases of the epidemic; fevers frequent in autumn. (8th) At 800 meters to the north. (9th) There is none. (10th) Equally.



(11th) Traversed by a gully which contains a large quantity of water during the rainy weather. (12th) The part near the gully has always been most attacked. (13th) By land. (14th) Disinfectants. (15th) Abuse of fruits. (16th) Generally in basins and in the houses. (17th) 42 days—ascend, 16; apogee, 10; descent, 16. (18th) The maximum of cholera increased during cloudy weather. (19th) No. (20th) 104 attacks—50 males, 54 females. (21th) 45 deaths—15 males, 30 females. (22d) Inhabited only the first stories. (23d) There are none. (24th) The first two cases were fatal; they infected three other persons who were found in bad circumstances as to food and mode of life.

*Albarca, Agregado y Cornudella, 2,542 inhabitants.*—(1st answer.) From the 7th to the 25th of August. (2d) Imported by a sick person from an infected place whose mother washed clothing in a water-tank which supplied the population. (3d) First good; second bad. (4th) There is none; filth into the court-yards, and public cleaning wanting. (5th) Spring water; lime; hard and agreeable. (6th) It was observed that the cholera was propagated in persons who used the tank water in which the clothing of the first case was washed. (7th) Calcareous and sandy; no fevers. (8th) In the village, but during the epidemic in a location with good hygienic surroundings. (9th) There is none. (10th) No former epidemics. (11th) Upon the side of a hill. (13th) Highways and neighboring roads. (14th) Disinfectants. (15th) No. (16th) In streams at some distance. (17th) 18 days; its apogee on August 14; rapidly descending afterwards until the 25th. (18th) The time of the epidemic it was cloudy. (19th) No. (20th) 20 attacks—9 males, 11 females. (21st) 12 deaths—5 males, 7 females. (22d) Indifferently. (23d) There are none.

*Cambries, 2,480 inhabitants.*—(1st answer.) From the 5th to the 21st of August. (2d) By a person and by effects from infected places; in the Marina ward. (3d) Bad. (4th) There is none. (5th) Springs supply most of the population, and a well in the Marina ward. (6th) Yes. (7th) Sandy and limestone, very flat and very porous. (9th) There is none. (11th) On the sea-shore. (12th) The Marina ward, which was very damp, suffered most. (13th) By sea and land. (17th) 17 days. (20th) 187 attacks. (21st) 45 deaths.

#### PROVINCE OF GERONA.

*Bañolas, 5,000 inhabitants.*—(1st answer.) From the 20th of August to the 11th of October. (2d) Imported by continuous communication with infected villages. (3d) Both good. (4th) There is none; filth deposited in the court-yards; cleaning by the municipality. (5th) Springs proceeding from the mountain, and containing lime. (7th) Tertiary and limestone soil. (9th) Iron pipes. (11th) Village is situated near a lake 5 kilometers in length; from the latter issue 5 canals for irrigation of the surrounding fields. (12th) The street, whose inhabitants used the lake water and well water in Mata ward, as also those located lower down, furnished the greatest number of attacks; in the latter the water from the upper streets is collected after having been used for washing. (14th) Cordons and lazarettos at the beginning; afterwards disinfectants. (16th) Generally in the water of the lake, which is fed by rains. (17th) 53 days. (19th) Preceded by colics and intestinal disturbances. (20th) 154 attacks. (21st) 60 deaths—20 males, 40 females. (22d) Each formerly occupied an entire house.

*San Privat de Bas, 1,690 inhabitants.*—(1st answer.) From the 24th of August to the 27th of September. (2d) Through attacks by persons from infected places. (3d) Both good. (4th) There is none. (5th) Spring and well water; good, agreeable, and hard. (6th) No. (7th) Sand and clay; no marshes nor fevers. (8th) Within the village. (9th) There is none. (10th) No former epidemic. (11th) Small stream at the extreme edge of the district is the river Fluvia. (13th) By land. (14th) Isolation and disinfectants. (15th) No. (16th) In streams and springs. (17th) 34 days. (18th) No. (19th) Yes. (20th) 14 attacks—7 males, 7 females. (21st) 6 deaths—3 males, 3 females.

#### PROVINCE OF BARCELONA.

*Barcelona, 249,106 inhabitants.*—(1st answer.) From the 8th of July to the 30th of October. (2d) Imported by persons from Valencia. (3d) Bad. (4th) The narrow sewers wanting declivity and water; their walls are porous. (5th) Springs; a part of the city is supplied by the Llobre-

gat ; there are wells in the houses for domestic uses. (7th) Alluvial soil ; subsoil clay and limestone. (9th) Iron pipes. (10th) Suffered more in the former. (11th) Sea-port, situated between the Besos and Llobregat. (12th) The ward Barlerioetat suffered most ; inhabited by sailors and fishermen. (13th) Railway ; by sea and land. (14th) Medical inspection and disinfectants. (15th) Yes, especially the working classes. (16th) In public lavatories, generally outside of the houses. (17th) 114 days—ascend, 47 ; apogee, 17 ; descent, 50. (18th) Began with a marked fall of the barometer and heavy rain. (19th) Yes. (20th) 2,223 attacks. (21st) 1,323 deaths—456 males, 867 females. (23d) In the garrison, convents, and prisons there was light mortality. (24th) The greatest development of the epidemic occurred where the sewers were narrowest and had the least declivity.

*Garcia, 33,766 inhabitants.*—(1st answer.) From the 1st of August to the 8th of October. (2d) By clothing from Barcelona, washed in public lavatories. (3d) Both generally good. (4th) There is none ; dirty water reaches the wells in some houses by filtration. (5th) Springs good, containing carbonate of lime and magnesia. (6th) No. (7th) Clay, and the upper part granite and sandy ; no marshes nor fevers. (8th) There is none ; that of Barcelona used. (9th) The principal is of iron pipes, some of lead. (10th) Former more. (11th) No. (12th) More in the lower portion of the houses ; none in the upper. (13th) All. (14th) Disinfectants. (15th) Considerable, but it was prohibited. (16th) Usually in public lavatories ; very few give wash out. (17th) 69 days—ascend, 22 ; apogee, 17 ; descent, 30. (18th) No. (19th) In general. (20th) 251 attacks—80 males, 171 females. (21st) 160 deaths—50 males, 110 females. (22d) More in the lower ; rare to the south ; considerable to the east and south ; some to the west.

*Manresa, 16,525 inhabitants.*—(1st answer.) From the 16th of August to the 23d of October. (2d) Imported by persons from Barcelona and Grosgoza. (4th) The sewers are bad because they have no declivity and they are porous. (5th) From the river Llobregat ; many villages up-stream generally using the same water were not attacked. (7th) The center of the village, upon a limestone rock ; two hills ; great moisture of the soil ; two canals from the Llobregat. (9th) Open canal. (11th) Upon the river Cardoner, which is used only for manufacturing ; at the confluence of this river and Llobregat. (12th) The most unhygienic parts were most attacked. (14th) Disinfectants ; many fires in the streets at night, with large quantities of sulphur ; assistance to the needy. (20th) 373 attacks. (21st) 137 deaths.

*San Hipólito de Voltrega, 1,280 inhabitants.*—(1st answer.) From the 25th of August to the 1st of October. (3d) Both miserable. (4th) Defective ; generally the house contains a sink which overflows into the street. (5th) There are only fountains and water supplied from rain, which is collected in cisterns. (7th) In a favorable sight. (11th) At a half league from the river Tiber. (14th) Nothing ; on account of the great number of the attacks ; on August 24th there were half a hundred. (15th) Yes. (20th) 333 attacks. (21st) 106 deaths.

*San Pedro de Torelló, 892 inhabitants.*—(1st answer.) From the 2d of September to the 11th of October. (2d) By persons from infected places. (3d) First good ; second bad. (4th) There is none ; night-soil in court-yards ; cleaning by the municipality. (5th) Springs good, containing lime and magnesia. (6th) Where the foci were located they did not use suspected water. (7th) On the side of a mountain ; perpetual east wind ; no marshes nor fevers. (8th) At 1 kilometer. (9th) There is none. (10th) The former greater. (11th) In a dry place. (13th) Neighboring roads. (14th) Disinfectants. (15th) Yes. (16th) In streams, rivers, and pools. (17th) 39 days—ascend, 6 ; apogee, 15 ; descent, 18. (18th) Yes. (19th) Yes. (20th) 35 attacks—18 males, 17 females. (21st) 14 deaths—9 males, 5 females. (22d) All in the lower. (23d) There are none. (24th) Bad food ; filth.

*Igualada, 11,879 inhabitants.*—(1st answer.) From the 2d of August to the 13th of October. (2d) Suspected by persons. (3d) First good ; second bad. (4th) There is none ; night-soil sold for manure ; municipality cleans. (5th) Spring water good, containing lime and magnesia. (6th) No. (7th) Clay and gypsum ; dry soil without fevers. (8th) At 1 kilometer. (9th) Of brick. (10th) Equally. (11th) A few meters from the village there is a small river used for irrigation. (12th) The part which suffered least was near the river ; in the surrounding *huerta* there were no deaths. (13th) Highways. (14th) Disinfectants. (15th) Abstained during the epidemic. (16th) In public lavatories. (17th) 72 days—ascend, 28 ;



apogee, 12; descent, 32. (18th) Yes. (19th) Yes. (20th) 450 attacks—166 males, 284 females. (21st) 121 deaths—41 males, 80 females. (22d) Unknown. (23d) There are none. (24th) Some ate unripe fruit; were attacked with cholera.

*Vich, 12,478 inhabitants.*—(1st answer.) From the 2d of August to the 19th of September. (2d) By persons. (3d) Both ordinary. (4th) Bad; sewers flushed by the superfluous water from the fountain; cleaning by the municipality. (5th) Good spring water and cisterns. (6th) No. (7th) Tertiary; clay, no marshes nor fevers. (8th) At 225 meters. (9th) Three kinds. (10th) The only epidemic that of 1854 was greater. (11th) Upon a stream. (13th) Railways. (14th) Disinfectants and heat. (15th) Yes. (16th) In public lavatories and running water. (17th) 47 days. (18th) Attacks increased after feasts. (19th) Yes, during the month previous. (20th) 58 attacks—25 males, 33 females. (21st) 28 deaths—11 males, 17 females. (22d) Unknown. (23d) There are none. (24th) The clothing of cholera patients was washed in the Ter; a little while afterward, various villages on the Tiber were attacked.

*Las Corts, 2,547 inhabitants.*—(1st answer.) From the 6th of August to the 1st of October. (2d) By persons from infected places. (3d) Good. (4th) There is none; household sewerage into very deep blind wells. (5th) Good spring water. (6th) Not probable. (7th) Good; permeable sandy soil; no marshes nor fevers. (8th) At 2 kilometers. (9th) Of brick and iron. (10th) No epidemic before. (11th) Very far from the river and at a high elevation. (13th) Tramways. (14th) Disinfectants. (15th) Cantaloupes and watermelons. (16th) In public lavatories. (17th) 57 days—ascend, 14; apogee, 11; descent, 32. (18th) No. (19th) Yes. (20th) 28 attacks—10 children, 16 women, 2 aged. (21st) 23 deaths—2 aged, 10 men, 11 women. (22d) 25 in the lower, 3 in the upper, 19 to the north, 9 to the south. (23d) There are none.

*Badalona, 13,598 inhabitants.*—(1st answer.) From the 17th of August to the 27th of September. (2d) By persons and effects from an infected place. (3d) First good; second bad. (4th) There is none; excrement used for manure; cleaning by the inhabitants. (5th) Spring water, good, pleasant, and hard. (6th) No. (7th) Frequent fevers in autumn. (8th) At 1 kilometer. (9th) All kinds. (10th) More. (11th) There is a river at 3 meters, the Haro. (13th) Railway, river, and roads. (14th) Disinfectants. (15th) Considerable of all kinds; there was abstention during the epidemic. (16th) Public lavatories; washing usually not given out. (17th) 41 days—ascend, 20; apogee, 8; descent, 13. (18th) No. (19th) Yes. (20th) 76 attacks—26 males, 50 females. (21st) 34 deaths—12 males, 22 females. (22d) Equally.

*San Quirico de Besora, 1,454 inhabitants.*—(1st answer.) From the 19th of August to the 18th of September. (2d) It is thought by persons and effects. (3d) First good; second bad. (4th) There is none; cleaning by the inhabitants. (5th) The first is divided into two villages; both use well-water supplied by filtrations from the river Ter, and spring water. (6th) Water of the Ter. (7th) The highest calcareous the lowest clay. (7th) Filtration from the Ter; no fevers nor marshes. (8th) One at 200 meters; the other within the village, which was closed during the cholera, and another one was opened at 1½ meters. (9th) There is none. (10th) Both villages were much afflicted in 1854; six or seven times more than this. (11th) Both near the Ter. (12th) The part near the river somewhat more. (13th) Railways and highways. (14th) Hygiene, disinfectants, and feeding of the poor. (15th) Yes. (16th) In the Ter. (17th) 30 days—ascend, 5; irregular course. (18th) Yes. (19th) Yes. (20th) 44 attacks—25 males, 19 females. (21st) 17 deaths—10 males, 7 females. (22d) 36 in the lower, 8 in the upper; to the north 22, to the south 12. (23d) There are none.

*San Ginés de Vilasar, 3,094 inhabitants.*—(1st answer.) From the 20th of August to the 16th of October. (2d) By persons. (3d) Good. (4th) There is none; the filth removed in carts the charge at of the municipality. (5th) Good spring water. (6th) No. (7th) Granite and limestone; no marshes nor frequent fevers. (8th) At 640 meters. (9th) Of brick. (10th) The anterior more severe. (11th) No. (12th) The death in the street near the river. (13th) Railways and neighboring roads. (14th) Disinfections and isolation. (15th) Yes. (16th) In public lavatories. (17th) 57 days—ascend, 43; apogee, 2; descent, 12. (18th) No. (19th) Yes. (20th) 12 attacks—6 males, 6 females. (21st) 8 deaths—4 males, 4 females. (22d) 11 in the lower, 1 in the upper; to the north 3, to the south 9. (23d) There are none.

*Prat de Llobregat*, 2,134 inhabitants.—(1st answer.) From the 26th of August to the 23d of October. (2d) By persons. (3d) First bad; second ordinary. (4th) There is none; the municipality. (5th) Water from the river Llobregat; considered good. (6th) Unknown. (7th) Clay; surrounded by four marshes; fevers are endemic. (8th) At 1 kilometer. (9th) There is none. (10th) In 1854 greater; that of 1865 same as this. (11th) On the Llobregat. (12th) Equally. (13th) Railway and highway. (14th) Disinfectants. (15th) Yes. (16th) In the houses. (17th) 58 days—ascend, 27; apogee, 10; descent, 21. (18th) Yes; with rapidity after 24 hours. (19th) Yes. (20th) 52 attacks—28 males, 24 females. (21st) 18 deaths—11 males, 7 females. (22d) Equally. (23d) There are none.

*Hospitalet*, 3,643 inhabitants.—(1st answer.) From the 30th of August to the 7th of October. (2d) By persons. (3d) Good. (4th) There is none; no public cleaning. (5th) Good spring water. (6th) No. (7th) Sandy clay; no marshes nor frequent fevers. (8th) At 1 kilometer. (9th) Of iron. (10th) That of 1854 greater; that of 1865 same as this. (11th) At 2 kilometers from Llobregat. (12th) There is no part along the river. (13th) Railways and highways. (14th) Disinfectants. (15th) No. (16th) In basins and in canals. (18th) No. (19th) No. (20th) 6 attacks—4 males, 2 females. (21st) 4 deaths—3 males, 1 female. (22d) In the lower and to the south. (23d) No cases.

*Suria*, 1,755 inhabitants.—(1st answer.) From the 10th of September to the 22d of October. (2d) Unknown. (3d) All bad. (4th) Bad in general; little; cleaning by the municipality. (5th) Filters from the river Cordoner into the wells. (6th) All of the houses where they used this water. (7th) Calcareous; no marshes nor fevers. (8th) In the center of the village; this was closed and another opened at 2 kilometers. (9th) There is none. (10th) This time greater. (11th) Upon the river Cordoner. (12th) The part next the river 10 per cent. more. (13th) Highways. (14th) Disinfectants. (15th) Yes. (16th) In the river. (17th) 42 days—ascend, 16; apogee, 7; descent, 9. (18th) No. (19th) Yes. (20th) 278 attacks—118 males, 160 females. (21st) 87 deaths—42 males, 45 females. (22d) More to the north than to the south. (23d) There are none.

*Balsareny*, 1,505 inhabitants.—(1st answer.) From the 15th of September to the 10th of October. (2d) Unknown; supposed by infection of the Llobregat. (3d) Both bad. (4th) There is none; cleaning by the inhabitants. (5th) Poor springs, cisterns, and wells; majority use the water from the river Llobregat. (7th) The soil is variable; no marshes nor fevers, except at certain times. (8th) Adjoining the village. (9th) Of brick. (10th) Less than 1854. (11th) At 750 meters from the river; 80 meters above it. (12th) Equally. (13th) Tramways or railways and highways. (14th) Disinfectants. (15th) Yes. (16th) In the streams and in the river; at present it is prohibited. (17th) 25 days in two periods; short descent. (18th) No. (19th) Yes. (20th) 36 attacks—16 males, 20 females. (21st) 5 deaths—3 males, 2 females. (22d) Equally. (23d) There are none.

*Callús*, 304 inhabitants.—(1st answer.) From the 20th of September to the 23d of October. (2d) It is suspected that a woman was attacked on account of having drunk water from the infected river. (3d) First good; second bad. (4th) There was a sewer only in one street. (5th) Upon a river; wanting; from wells near to the river. (6th) Yes. (7th) Sandy; no marshes nor fevers. (8th) At 20 minutes; on the side of a mountain. (9th) Natural course. (11th) Upon a river. (12th) 85 per cent. in the part near the river. (13th) Highways. (14th) Disinfectants. (15th) Yes. (16th) Formerly in the river; during the epidemic in public lavatories. (17th) 34 days—ascend, 13; apogee, 9; descent, 12. (18th) Yes, as regards attacks. (19th) No; during the epidemic. (20th) 78 attacks—42 males, 36 females. (21st) 15 deaths. (22d) 65 in the lower, 14 in the upper. (23d) There are none. (24th) It began in the lower part; three attacks since; ceased and began with considerable vigor in the part opposite the river, where the houses and the people are in better condition.

#### PROVINCE OF BADAJOZ.

*Villanueva de la Serena*, 10,710 inhabitants.—(1st answer.) From the 23d of July to the 8th of August. (2d) By persons who had immediate communication with others from infected places. (3d) First good; second bad. (4th) There is none; each inhabitant removes the filth.



periodically. (5th) Good spring and well water. (6th) No. (7th) Sandy in some places; subsoil calcareous; some intermittent fevers in summer. (8th) At 100 meters. (9th) Of iron. (10th) In 1834 severe; in subsequent epidemics more benign. (11th) The Guadiana is at 5 kilometers distance. (13th) Highways and roads. (14th) All. (15th) Yes. (16th) In various rivers; usually outside of the house. (17th) 15 days. (18th) No. (19th) No. (20th) 15 attacks—8 males, 7 females. (21st) 8 deaths. (22d) Only the lower stories inhabited. (23d) No attack in the post of the civil guard.

*Jeréz de los Caballeros*, 8,463 inhabitants.—(1st answer.) From the 23d of September to the 6th of October. (2d) It is thought by washing clothing of individuals from Jaen. (3d) Both good. (4th) There are deficient sewers in some streets; the excrement is thrown into the streets or into the court-yards; latines are generally wanting; cleaning by the municipality. (5th) Good; soft spring water, containing a small quantity of lime and magnesia. (6th) No. (7th) Granite; near a marsh; intermittent fevers frequent all the year. (8th) There are two cemeteries, in bad hygienic condition, at 200 meters from the village. (9th) Of brick. (10th) This time less. (11th) There are rivers which flow near the village; the Tejares and the Ronquitas; the water of the first being examined was found to contain the comma bacillus of Koch, and in it suspected clothing was washed. (12th) All the attacks were near the river Tejares. (13th) Roads and highways and railways. (14th) All. (15th) Abuse of fruits and vegetables. (16th) In stream and pools within and outside of the village; the washing is given out. (17th) 14 days—ascend, 2; apogee, 2; descent, 10. (18th) No. (19th) Yes. (20th) 17 attacks—8 males, 9 females. (21st) 12 deaths—4 males, 8 females. (22d) All in the lower; to the north, 8; to the south, 9. (23d) No attacks in the garrison or prison.

*Don Benito*, 14,692 inhabitants.—(1st answer.) From the 12th of July to the 30th of August. (2d) Imported by a person and clothing from Valencia. (3d) Both bad. (4th) No sewerage; only sinks; public cleaning by private individuals. (5th) Well and spring water. (6th) No. (7th) Sandy soil, with clay subsoil; very fertile. (9th) Iron pipes. (10th) Less this time. (11th) To the south of the Guadiana; surrounded by streams. (13th) Railway and neighboring roads. (14th) Cordons, lazarettos, and afterwards disinfectants. (15th) Yes. (16th) In streams; majority in their houses. (17th) 49 days—ascend, 18; apogee, 9; descent, 22. (18th) No. (19th) No. (20th) 913 attacks. (21st) 532 deaths.

#### PROVINCE OF VALLADOLID.

*Cabezón*, 1,208 inhabitants.—(1st answer.) From the 13th of July to the 1st of September. (2d) Supposed by a lady. (3d) In general, good; the lower part is better than the upper; the latter contains subterranean houses. (4th) There is none; filth deposited in the courts; there is always some one to clean them; public cleaning by the municipality. (5th) From the Pisuerga, and from fountains supplied by springs; all good. (6th) No; only from the river. (7th) Clay; fevers frequent in the spring, when the waters of the Castilla Canal are low. (8th) At 1 kilometer. (10th) The same. (11th) On the banks of the Pisuerga. (12th) None near the river. (13th) Railways and highways. (14th) Disinfectants. (15th) No. (16th) In the river, usually, and in the fountains. (17th) 50 days—ascend, 18; apogee, 7; descent, 25. (18th) Yes. (19th) Yes. (20th) 131 attacks—32 men, 79 women, 20 children. (21st) 61 deaths—23 males, 38 females. (22d) In the lower, 28; in the upper, 3; to the north, 21; to the south, 110. (23d) A third part of the attacked refused to receive medical assistance, using household remedies of unknown constitution.

*Valdestillas*, 895 inhabitants.—(1st answer.) From the 19th of July to the 29th of August. (2d) Suspected by river water in which the comma bacillus of Koch was found. (3d) Both good. (4th) There is none; the filth removed in carts; the town is located on a declivity, and the rain-water flows to the river. (5th) From the river Adaja; good; lime and magnesia. (6th) The river water, it is thought, was the cause. (7th) Sandy; subsoil clay; there is a marsh; fevers in autumn. (8th) At 200 meters. (9th) There is none. (10th) The former more. (11th) On the banks of the Adaja. (12th) None near the river. (13th) Railway and river. (14th) Disinfectants. (15th) No. (16th) In the river. (17th) 42 days—ascend, 15;

apogee, 10; descent, 17. (18th) Yes; developed the day of the storm. (19th) No. (20th) 162 attacks—70 males, 92 females. (21st) 20 deaths—8 males, 12 females. (22d) Unobserved. (23d) There are none.

*Alcazaren*, 1,186 *inhabitants*.—(1st answer.) From the 19th to the end of August. (2d) By persons. (3d) Both bad. (4th) There is none; no public cleaning. (5th) Spring water; good; from the river Eresma; the latter prohibited. (6th) No. (7th) Sand and clay; the water stagnates and forms pools; endemic fevers; more in autumn. (8th) At  $2\frac{1}{2}$  kilometers. (9th) Of brick. (10th) Some cases in the former. (11th) At 2 kilometers from the river Eresma. (12th) Unknown. (13th) By land. (14th) Good hygiene; some disinfectants. (15th) Yes; during the cholera in moderation. (16th) In public lavatories; prohibited washing in the river. (17th) Could not determine. (18th) Unappreciable. (19th) Not observed. (20th) 8 attacks—1 man, 5 women, 2 children. (21st) 3 deaths—1 male, 2 females. (22d) In the lower. (23d) There are none.

*Aldea de San Miguel*, 503 *inhabitants*.—(1st answer.) From the 22d of July to the 6th of September. (2d) By persons. (3d) First bad; second ordinary. (4th) There is none; deposited in the courts; cleaning by the municipality. (5th) Good spring and well water. (6th) No. (7th) Clay and sand; various lakes and fevers not frequent. (8th) Near the village. (9th) There is none. (10th) The former less severe. (11th) No. (12th) There are no rivers. (13th) By land. (14th) Disinfectants. (15th) No. (16th) In the lake and in the house. (17th) 45 days—ascend, 15; apogee, 5; descent, 25. (18th) Yes. (19th) No. (20th) 264 attacks—118 males, 146 females. (21st) 64 deaths—22 males, 42 females. (22d) All in the upper; to the north 74; to the south 101. (23d) There are none.

*Santovenia*, 276 *inhabitants*.—(1st answer.) From the 24th of July to the 18th of August. (2d) Thought imported by a physician in the exercise of his profession. (3d) First good; second bad. (4th) There is none; deposited in the court-yards; no public cleaning. (5th) From the river and springs, the latter of unknown origin; soft. (6th) No. (7th) Calcareous; lakes, and few intermittents. (8th) At 30 meters. (9th) There is none. (10th) No epidemic before. (11th) At considerable height above the river Pisuerga. (12th) There were none. (13th) By land. (14th) Nothing. (15th) No. (16th) In the surrounding fields during the winter, and in the river during the summer; the clothing of the capital of the province is brought to this village to be washed. (17th) 25 days. (18th) Unknown. (19th) Yes. (20th) 5 attacks—1 male, 4 females. (21st) 2 deaths—1 male, 1 female. (22d) All in the lower, and none to the north.

*Pollos*, 1,170 *inhabitants*.—(1st answer.) From the 21st of July to the 25th of September. (2d) It is believed by travelers and by clothing from Madrid. (3d) The place is marshy. (4th) Wanting. (5th) From the river Duero; at the beginning of the epidemic used spring water. (6th) Some used the river water. (7th) Sandy and clayey; there are lakes and frequent intermittent fevers in autumn. (8th) At 50 meters. (9th) There is none. (10th) Less this time. (11th) At the confluence of the Duero and a small river called the Trabancus. (12th) Two-thirds in the part next the lake. (13th) Railway and highways. (14th) Disinfectants. (15th) Abuse of fruits and vegetables. (16th) In the streams. (17th) 67 days—ascend, 25; apogee, 12; descent, 30. (18th) 48 hours after a storm the attacks and the mortality increased. (19th) Yes. (20th) 138 attacks—35 males, 103 females. (21st) 14 deaths—2 males, 12 females. (22d) All lower; to the north, 85; to the south, 53.

*Nava del Rey*, 6,035 *inhabitants*.—(1st answer.) From the 1st of August to the 5th of September. (2d) By persons and effects. (3d) First good; second miserable. (4th) There is none; cleaning by the municipality. (5th) Springs, well-water, and reservoirs; all bad. (6th) No. (7th) Sandy and calcareous; there are marshes and rare fevers. (8th) The old in the village; since the epidemic there is another at 1,000 meters distance. (9th) There is none. (10th) That of 1834 was greater; that of 1855 less; in 1866 there was none. (11th) Dry, as respects rivers and streams. (13th) Railways and highways. (14th) Disinfectants. (15th) Only of grapes. (16th) In the house. (17th) 35 days—ascend, 6; apogee, 19; descent, 10. (18th) Yes. (19th) Unknown. (20th) 469 attacks—175 males, 294 females. (21st) 201 deaths—83 males, 118 females. (22d) 453 in the lower; 16 in the upper; three-fourths to the south;



one-fourth to the north. (23d) No cases in the post of the civil guard; one in the prison of the district.

*Castrillo, 544 inhabitants.*—(1st answer.) From the 3d of August to the 3d of September. (2d) Imported by persons. (3d) Nothing good. (4th) There is none; cleaning left to the inhabitants. (5th) Good spring water. (6th) No. (7th) Located in a valley; of various soil; no marshes nor fevers. (8th) Within the village. (9th) Of brick; bad condition. (10th) Former less. (11th) Near the stream. (12th) Little difference. (13th) By land. (14th) Disinfectants. (15th) No. (16th) In the stream. (17th) 31 days—ascend, 10; apogee, 4; descent, 17. (18th) No. (19th) Unknown. (20th) 37 attacks—17 males, 20 females. (21st) 14 deaths—4 males, 10 females. (22d) Equally. (23d) There are none.

*Valbuena de Duero, 765 inhabitants.*—(1st answer.) From the 14th of August to the 7th of September. (2d) By persons from infected places, and by water from the river Duero. (3d) Both bad. (4th) There is none; deposited in the court-yards of the houses; no public cleaning. (5th) From the river Duero; containing lime and magnesia. (6th) Those who used the Duero water were attacked. (7th) Sand and clay; no marshes; intermittent fevers not very frequent. (8th) At 300 meters. (9th) There is none. (10th) Three times more, the present. (11th) Upon the Duero at its confluence with a small stream. (12th) Equally. (13th) By land. (14th) Disinfectants and isolation. (15th) Abuse of fruits and vegetables. (16th) Each one in the river. (17th) 24 days—ascend, 6; apogee, 4; descent, 14. (18th) No. (19th) Yes. (20th) 78 attacks—39 males, 39 females. (21st) 19 deaths—9 males, 10 females. (22d) All in the lower; to the north, 20; to the south, 48. (24th) Poverty, want, resistance to removal to the cholera hospital and to the taking of medicines ordered by the physician.

*Villanueva de los Infantes, 273 inhabitants.*—(1st answer.) From the 8th of August to the 6th of September. (2d) By persons. (3d) First good; second miserable. (4th) There is none; cleaning by the municipality. (5th) From the river Esgueva; good; containing lime; the river was considered infectious. (7th) Calcareous and clayey; no marshes nor fevers. (8th) Within the village. (9th) There is none. (10th) A third less than the former. (11th) Upon the river Esgueva. (12th) Equally. (13th) By land. (14th) Disinfectants. (15th) No. (16th) In the river. (17th) 30 days—ascend, 15; apogee, 4; descent, 11. (18th) No. (19th) Yes. (20th) 149 attacks—74 males, 75 females. (21st) 33 deaths—7 children, 13 men, 13 women. (22d) All in the lower; to the north, 100; to the south, 49. (23d) 20 per cent. of the attacks in the post of the civil guard.

*Megecer, 376 inhabitants.*—(1st answer.) From the 9th to the 28th of August. (2d) Unknown. (3d) Both good. (4th) There is none; cleaning by the municipality. (5th) Good river water, containing lime. (6th) From the river. (7th) Clay; no marshes nor intermittent fevers. (8th) Within the village. (9th) There is none. (10th) Equally. (11th) Upon the river. (12th) Equally. (13th) By land. (14th) Disinfectants. (15th) Abuse of fruits and vegetables. (16th) In the river. (17th) 19 days—ascend, 7; apogee, 6; descent, 6. (18th) Began after a storm. (19th) Yes. (20th) 19 attacks—9 males, 10 females. (21st) 10 deaths—4 males, 6 females. (22d) 1 in the upper; 18 in the lower; to the north, 8; to the south, 9.

*Villabáñez, 902 inhabitants.*—(1st answer.) From the 11th of August to the 25th of September. (2d) By persons. (3d) First good; second ordinary. (4th) There is none; no public cleaning. (5th) Spring water and river Duero water; the latter preferred. (6th) No. (7th) Clay; no marshes nor fevers. (9th) Part of brick; part of stone, and another part of cement. (10th) In 1855 greater. (11th) A stream at 200 meters distance, and the river at 2 kilometers. (13th) Neighboring roads. (14th) Disinfectants. (15th) No. (16th) Usually in the river. (17th) 46 days—ascend, 15; apogee, 8; descent, 23. (18th) Yes; in 24 hours; the greatest mortality on rainy days. (19th) Yes. (20th) 4 attacks—2 males, 2 females. (21st) 4 deaths—2 males, 2 females. (22d) Equally.

*Mollados, 575 inhabitants.*—(1st answer.) From the 1st of August to the 9th of September. (2d) Unknown. (3d) Both miserable. (4th) There is none; no cleaning. (5th) From the river and fountains. (6th) No. (7th) Sandy and siliceous; no marshes nor fevers. (8th) At 1 kilometer. (9th) There is none. (10th) That of 1834 greater; that of 1855 less. (11th) On the bank of the river Cega; there is also a stream whose water is suspected. (12th) By

100 per cent. (13th) By land. (14th) Disinfectants. (15th) Yes; much. (16th) In streams and in pools. (17th) 39 days—ascend, 17; apogee, 10; descent, 12. (18th) The descent of the epidemic coincided with storm. (19th) Little; on account of excesses. (20th) 72 attacks—34 males, 38 females. (21st) 25 deaths—12 males, 13 females. (22d) In the lower, 35; in the upper, 37; to the north, 20; to the south, 52. (23d) No cases in the post of the civil guard.

*Piña de Esgueva, 657 inhabitants.*—(1st answer.) From the 11th of August to the 10th of September. (2d) In part by persons. (3d) Both ordinary. (4th) There is none; municipality cleans. (5th) Good spring water; water from the river Esgueva preferred; the second is malarial in the summer. (6th) The river water suspected. (7th) Clayey; no marshes; rare fevers in the summer. (8th) At 1 kilometer. (9th) There is none. (10th) Equally. (11th) Near the river Esgueva. (12th) The majority near the river. (13th) Highways. (14th) Disinfectants. (15th) Yes, but it was prohibited. (16th) In the river. (17th) 30 days—ascend, 8; apogee, 3; descent, 19. (18th) No. (19th) Yes; 15 days before. (20th) 114 attacks—54 males, 60 females. (21st) 24 deaths—14 males, 10 females. (22d) All in the upper; 95 per cent. to the south. (23d) There are none. (24th) Want of food and hygiene.

*Castromonte, 913 inhabitants.*—(1st answer.) From the 13th of August to the 23d of September. (2d) By persons; harvesters who drank stagnant water. (3d) First good; second bad. (4th) There is none; cleaning by the board of health. (5th) Good spring water. (6th) No; but all of the water-jars were repeatedly immersed in the fountains. (7th) Good conditional calcareous soil; village surrounded by streams; fevers frequent. (8th) At 50 steps from the village. (9th) There is none. (10th) The former was very severe. (11th) The upper part is surrounded by streams. (12th) The upper part suffered a third more. (13th) By land. (14th) Disinfectants. (15th) Yes. (16th) In the streams. (17th) 41 days—ascend, 21; apogee, 8; descent, 12. (18th) Yes. (19th) Yes. (20th) 121 attacks—30 men, 37 women, 33 boys, 21 girls. (21st) 28 deaths—8 males, 20 females. (22d) 120 in the lower. (23d) There are none.

*Canalejas de Peñafiel, 751 inhabitants.*—(1st answer.) From the 15th of August to the 15th of September. (2d) Unknown; the first case in a man in the fields. (3d) The first ordinary; the second defective by want of ventilation. (4th) Nothing good; no sewers. (5th) From two springs; one better than the other. (6th) No. (7th) Calcareous; there are wells for the manufacture of hemp; no fevers. (8th) At 600 meters. (9th) There is none. (10th) The former were not important. (11th) At 2 kilometers from the river. (12th) The part overlooking the river was first attacked. (13th) Neighboring roads. (14th) Little of disinfectants. (15th) Yes; unripe fruits. (16th) In the public lavatory. (17th) 31 days—ascend, 15; apogee, 8; descent, 8. (18th) Yes; the first case appeared four days after the storm; the greatest mortality coincided with rains. (19th) No. (20th) 100 attacks—35 men, 50 women, 15 children. (21st) 31 deaths—14 men, 9 women, 8 children. (22d) In the lower and to the south. (24th) Abuse of fruits; fear; atmospheric conditions.

*Manzanillo, 234 inhabitants.*—(1st answer.) From the 11th to the 24th of August. (2d) Unknown. (3d) First good; second bad. (4th) There is none; filth emptied into the court-yards. (8th) At 250 meters. (9th) There is none. (10th) This time greater. (11th) Upon a stream. (12th) Equally. (13th) Neighboring roads. (15th) Some. (16th) In the stream. (17th) 13 days—ascend, 3; apogee, 4; descent, 6. (18th) No. (19th) Yes. (20th) 112 attacks—50 males, 62 females. (21st) 14 deaths—6 males, 8 females. (22d) In the lower. (24th) A physician died of cholera without medical assistance.

*Benafarces, 457 inhabitants.*—(1st answer.) From the 16th of August to the 20th of September. (2d) Unknown. (3d) First fair; second bad. (4th) There is none; cleaning by the municipality. (5th) Good spring water. (6th) No. (7th) Calcareous; there are marshes and fevers the whole year. (8th) At 80 meters. (9th) Of brick. (10th) The former greater. (11th) At the confluence of various streams. (13th) By land. (14th) Vigilance, cordons, and disinfectants. (15th) No. (16th) In streams and pools. (17th) 35 days—ascend, 18; apogee, 8; descent, 9. (18th) Yes. (19th) Yes. (20th) 43 attacks—26 males, 17 females. (21st) 18 deaths—10 males, 8 females.

*Simancas, 1,247 inhabitants.*—(1st answer.) From the 16th to the 28th of August. (2d) Not imported by persons or effects; the first case was a youth of 25 years, who had eaten



unripe fruits in abundance. (3d) Both good. (4th) There is none; deposits in the court-yards removed in the summer. (5th) Spring water; good, and conducted by terra-cotta pipes; water of the river Pisuerga prohibited during the epidemic, on account of its bad condition. (6th) No. (7th) Upon an elevation of 50 meters; calcareous; no marshes nor intermittent fevers. (8th) At 500 meters to the north. (9th) Of terra cotta. (10th) In 1834 twice as great; in 1855 and 1865 scarcely any. (11th) Upon the river Pisuerga. (12th) Equally. (13th) By land. (14th) Disinfectants; isolation of the families of the sick. (15th) Very frequent, and the poor people who ate them died. (16th) In the river; there are fountains with lavatories adjoining; washing in the river prohibited during the epidemic. (17th) 13 days—ascend, 3; apogee, 1; descent, 9. (18th) Immediately after the storm. (19th) Yes. (20th) 115 attacks—49 males, 66 females. (21st) 14 deaths—6 males, 8 females. (22d) In the upper stories, and equally in the north and south.

*Quintanilla de Arriba, 734 inhabitants.*—(1st answer.) From the 17th of August to the 19th of September. (2d) By persons. (3d) First good; second bad. (4th) There is none; no public service. (5th) Water of the river Duero thought to be excellent; prohibited during the cholera, when that from neighboring springs was used. (6th) Yes. (7th) Sand and clay; marshes; fevers rare in autumn. (8th) At 500 meters. (9th) There is none. (10th) This time a little less; upon the river Duero. (12th) Can not answer; equally. (13th) By land and river. (14th) Disinfectants. (15th) Yes; prohibited during the cholera. (16th) In the river in general; during the cholera in streams proceeding from springs. (17th) 33 days—ascend, 12; apogee, 3; descent, 18. (18th) No. (19th) No. (20th) 76 attacks—26 males, 50 females. (21st) 16 deaths—6 males, 10 females. (22d) In the lower and the majority of the south.

*Villanubla, 1,337 inhabitants.*—(1st answer.) From the 17th of August to the 21st of September. (2d) By persons from infected places. (3d) Both good. (4th) There is none; deposits in the courts. (5th) Springs containing magnesia. (6th) No. (7th) Clay; subsoil rocky; no intermittents. (8th) In the center of the village. (9th) Uncovered conduits. (10th) In 1834 more; in 1855 less. (11th) Along a stream formed by the overflow of fountains. (12th) The southeast part, near the stream. (13th) Railways, highways, and neighboring roads. (14th) Disinfectants; fumigation of those who arrived from without. (15th) No. (16th) In the streams. (17th) 36 days—ascend, 13; apogee, 7; descent, 16. (18th) Yes; coincided with storms and rains. (20th) 183 attacks—84 males, 99 females. (21st) 46 deaths—23 males, 23 females.

*Castronuño, 2,451 inhabitants.*—(1st answer.) From the 20th of August to the 19th of September. (2d) Unknown. (3d) Both bad. (4th) There is none. (5th) From the streams and from uncovered fountains and wells; use of the Duero water prohibited during the epidemic. (6th) No. (7th) Tertiary soil; alluvium, with strata of limestone; considerably elevated; no marshes nor frequent malarial fevers. (8th) Adjoining the village. (10th) In 1834 less; in 1854 much less; in 1865 there was none. (11th) On the margin of the Duero. (12th) Greater in the center, which was of a lower level. (13th) By rail and land. (14th) Disinfection of those from without, with little care. (15th) Yes. (16th) In the streams. (17th) 30 days—ascend, 10; apogee, 6; descent, 14. (18th) Influence of the fall of the barometer was felt in the first two periods. (19th) Yes. (20th) 200 attacks—80 males, 120 females. (21st) 42 deaths—16 males, 26 females. (22d) There are no upper stories.

*Casasola, 1,031 inhabitants.*—(1st answer.) From the 22d of August to the 2d of October. (2d) By persons from an infected place. (3d) Ordinary. (4th) There is none; filth removed by private individuals to the fields. (5th) Spring and well; good; containing lime. (6th) No. (7th) Calcareous and clayey; no marshes nor frequent fevers. (8th) At 700 meters. (9th) Of stone. (10th) Less this time. (11th) On the east and south, surrounded by a stream of small flow. (12th) Equally. (13th) By land. (14th) Vigilance, lazarettos of observation, fumigations, and disinfectants. (15th) Abuse of salads. (16th) In the rivers, but not during the epidemic. (17th) 42 days—ascend, 20; apogee, 5; descent, 17. (18th) Yes; within 24 hours. (19th) Yes. (20th) 92 attacks—41 males, 51 females. (21st) 47 deaths—22 males, 25 females. (22d) All the houses have one story.

*Cigales*, 1,850 inhabitants.—(1st answer.) From the 23d of August to the 23d of September. (2d) By communication with the neighboring villages, Calaceros and Mucientes. (3d) Good. (4th) There is none; the inhabitants remove the filth to a distance of 500 meters. (5th) Spring water, containing lime. (6th) No. (7th) Sand and clay; no marshes nor intermittent fevers. (8th) At 1,000 meters. (9th) There is none. In 1855 and 1865 there was none, thanks to good hygienic conditions; in 1834 it was not great, taking into account the crowding of persons employed in the opening of the Castilla canal. (11th) No. (13th) By land. (14th) Disinfectants. (15th) Frequent, but not during the epidemic. (16th) In the Castilla canal, at 4 or 5 kilometers; during the epidemic in fountains. (17th) 31 days—ascend, 10; apogee, 3; descent, 18. (18th) No; the descent coincided with rains. (19th) Yes. (20th) 135 attacks—55 males, 80 females. (21st) 15 deaths—5 males, 10 females. (22d) 80 lived in caves.

*Serrada*, 785 inhabitants.—(1st answer.) From the 26th of August to the 6th of October. (2d) By persons proceeding from Torresilla de Abadesa. (3d) Both bad. (4th) There is none; deposits in the court-yards; cleaning by the inhabitants. (5th) Springs; not potable. (6th) No. (7th) Sand and clay; many ponds to the south; intermittent fevers frequent. (8th) At 50 meters. (9th) There is none. (10th) Equally. (11th) No. (13th) Railway and by land. (14th) Disinfectants. (15th) Yes; canteloupes. (16th) In the river, in pools, and outside of the house. (17th) 41 days. (18th) Not observed. (19th) Yes. (20th) 6 attacks—1 male, 5 females. (21st) 5 deaths—females. (22d) All lower; 4 to the south; 2 to the north.

*Puente de Duero*, 264 inhabitants.—(1st answer.) From the 23d of August to the 4th of September. (2d) Originated in the place. (3d) Both fair. (4th) There is none; no public cleaning. (5th) Of the Duero. (6th) No. (7th) Sandy; surrounded by hills; no fevers. (8th) At 300 meters. (9th) There are none. (10th) No epidemic before. (11th) Upon the river Duero. (12th) Equally. (14th) Disinfectants. (15th) Cantaloupes. (16th) In the river Duero. (17th) 12 days—ascend, 4; apogee, 4; descent, 4. (18th) Yes. (19th) Yes. (20th) 28 attacks—12 men, 12 women, 4 children. (21st) 4 deaths—1 man, 2 women, 1 child. (22d) All in the lower. (23d) There are none.

*Valdenebro*, 674 inhabitants.—(1st answer.) From the 30th of August to the 23d of October. (2d) By persons. (3d) First, good; second, miserable. (4th) Nothing. (5th) Good spring-water; somewhat alkaline. (6th) No. (7th) Calcareous; no marshes nor fevers. (8th) At 1 kilometer. (9th) There are none. (10th) Much more. (11th) Situated at 10 meters above the river. (12th) Unknown. (13th) By land. (14th) Disinfectants. (15th) Vegetables. (16th) In public lavatories. (17th) 54 days—ascend, 20; apogee, 10; descent, 24. (18th) No. (19th) Yes. (20th) 42 attacks—16 men, 18 women, 8 children. (21st) 20 deaths—4 aged, 8 adults, 8 children. (22d) All in the lower; more to the north than to the south. (23d) There are none. (24th) Hygiene wanting; resistance to medical attention; poverty.

*Torrecilla de la Albadesa*, 539 inhabitants.—(1st answer.) From the 30th of August to the 23d of September. (2d) Supposed by fruits proceeding from Toro. (3d) Both very bad. (4th) Everything wanting. (5th) Hard spring-water, containing lime. (6th) No. (7th) Upper clayey; lower part sandy; intermittent fevers frequent in autumn. (8th) Adjoining. (9th) There are none. (10th) This time more. (11th) At a few kilometers from the Duero, and at the confluence of two streams. (12th) Double. (13th) By land. (14th) Disinfectants. (15th) With the exception of cantaloupes, watermelons, and cucumbers. (16th) Of all kinds. (17th) 25 days—ascend, 13; apogee, 3; descent, 9. (18th) No. (19th) Very much. (20th) 68 attacks—32 males, 36 females. (21st) 18 deaths—6 males, 12 females. (22d) All lower, and the majority to the south.

*Campillo*.—(1st answer.) From the 23d of September to the 15th of October. (2d) Unknown. (3d) First, bad; second, good. (4th) There is none; cleaning by contract. (5th) Good; springs; collected in cisterns. (7th) Sandy and calcareous; surrounded by marshes; malarial fevers endemic. (8th) At 80 meters. (9th) There are none. (10th) Unknown. (11th) Neither upon a stream nor a river. (12th) Unknown. (13th) Railways and roads. (14th) Cordons before the epidemic. (15th) Of fruits and vegetables, but not of grapes. (16th) In the houses. (17th) 22 days—ascend, 6; apogee, 7; descent, 9. (18th) Yes. (19th) Yes. (20th) 109 attacks—58 males, 51 females. (21st) 5 deaths—1 man, 3 women, 1 child. (22d) All in



the lower. (23d) There are none. (24th) Excessive eating of grapes; those who abstained were not attacked.

*Villanueva de las Torres*, 498 inhabitants.—(1st answer.) From the 17th of September to the 3d of October. (2d) It is thought by a person from an infected place. (3d) Fair. (4th) There is none; the filth is removed by the inhabitants to the fields. (5th) Usually wells; hard. (6th) No. (7th) Sandy; clayey and calcareous; there are marshes and frequent intermittent fevers in spring and autumn. (8th) At 200 meters. (9th) There are none. There was none in 1865; unknown before. (11th) Upon a stream. (13th) Neighboring roads. (14th) Cleaning (15th) Yes. (16th) In the houses and in fountains. (17th) 16 days. (18th) With cloudy weather. (19th) Yes. (20th) 59 attacks—30 males, 29 females. (21st) 12 deaths—8 males, 4 females.

*Amusquillo*, 253 inhabitants.—(1st answer.) From the 22d to the 30th of September. (2d) By persons from Valladolid. (3d) First, good; second, bad. (4th) There is none; cleaning by the inhabitants. (5th) From the river Esgueva; bad, especially in summer. (6th) From the river. (7th) Marl; the river Segura to the south; intermittent fevers in the spring and autumn. (8th) At 1 kilometer. (9th) There are none. (10th) In 1855 much. (11th) At 20 meters from the Esgueva. (12th) Equally. (13th) Highways and neighboring roads. (14th) Nothing; except prohibition of the river water. (16th) Predominance of vegetables; use of fruits prohibited. (16th) In the Esgueva. (17th) 8 days. (18th) With the storm. (19th) Yes. (20th) 22 attacks—10 males, 12 females. (21st) 12 deaths—5 males, 7 females. (22d) All lower.

*Rodilana*, 815 inhabitants.—(1st answer.) From the 26th of September to the 11th of October. (2d) By a woman who came from Medina sick; on the same day that she died her husband and her child were taken sick. (3d) Both bad. (4th) There is none; the inhabitants clean by order of the mayor. (5th) From the public well; containing lime. (7th) Mixture of clay and sand; there are marshes and pools; one of the latter in the center of the town and two to the north and south; intermittent fevers frequent in spring and autumn. (8th) At 300 meters (9th) There are none. (10th) More in the anterior; this was attributed to the want of hygienic measures. (11th) No. (13th) By land. (14th) Fumigations with sulphur in the streets. (15th) In moderation. (16th) In the pools within the village. (17th) 16 days. (18th) Less 2 days before the epidemic. (19th) Yes. (20th) 16 attacks—6 males, 10 females. (21st) 12 deaths—3 males, 9 females. (23d) The houses have only one story. (24th) The weak and those suffering with chronic diseases were the victims of the epidemic.

*Note*.—Aguilar de Campos, San Román de Hornija, and Valdeunquillo present nothing of interest; on account of the scarce data surrounding attacks and deaths. In one of them there was no deaths; in the others one.

#### PROVINCE OF ZAMORA.

\* *Malva*, 899 inhabitants.—(1st answer.) From the 24th of July to the 7th of September. (2d) Unknown. (3d) Both bad. (4th) There is none; cleaning by the inhabitants. (5th) Well-water, of origin unknown; containing magnesia. (6th) No. (7th) Clay; no marshes nor fevers. (8th) At 400 meters. (9th) There are none. (10th) Deaths in 1834, 40; in 1855, 14; in 1885, 74. (11th) Upon a stream caused by rains. (12th) Equally. (13th) By land. (14th) Fumigations and isolation. (15th) Abstained. (16th) In running water. (17th) 45 days. (18th) The descent coincided with a storm. (19th) No. (20th) 202 attacks—82 males, 120 females. (21st) 74 deaths—32 males, 42 females. (22d) All in the lower. (23d) There are none. (24th) Majority of the attacked badly fed.

*Villamor de los Escuderos*, 1,286 inhabitants.—(1st answer.) From the 22d of August to the 2d of October. (2d) Unknown. (3d) Both bad. (4th) There is none; irregular cleaning by the inhabitants. (5th) Fair spring-water. (6th) No. (7th) Granite, clay and sand; few fevers; no marshes. (8th) At 200 meters. (9th) There are none. (10th) Equally. (11th) Upon a stream. (12th) Equally. (13th) Neighboring roads. (14th) Disinfectants. (15th) Little. (16th) In streams adjoining the village. (17th) 41 days—march unobserved. (18th) Unknown. (19th) Yes. (20th) 52 attacks—28 males, 24 females. (21st) 24 deaths—13 males, 11 females. (22d) All in the lower; 40 to the south; 11 to the north, (23d) There are none.

*Guarrate, 623 inhabitants.*—(1st answer.) From the 7th of August to the 12th of September. (2d) By persons. (3d) Both good. (4th) There is none; night soil into the public streets; cleaning by the municipality. (5th) Rivers and wells, good. (7th) Sand and clay; no marshes nor fevers. (8th) Near the village. (10th) No epidemic before. (11th) Near two small rivers. (12th) Equally. (13th) By land. (14th) Disinfectants. (15th) Yes. (16th) In the streams. (17th) 26 days—ascend, 4; apogee, 7; descent, 15. (19th) Yes. (20th) 118 attacks—74 males, 44 females. (21st) 29 deaths—14 males, 15 females. (22d) All in the lower; 28 to the north; 90 to the south.

*Riego del Camino, 557 inhabitants.*—(1st answer.) From the 11th to the 29th of August. (2d) By persons. (3d) First, good; second, bad. (4th) No sewers; no public service. (5th) Good spring and well water. (6th) No. (7th) Good; granite; there is a marsh at 1 kilometer; few fevers in autumn. (8th) At 20 meters. (9th) There are none. (10th) This time greater. (11th) At 5 kilometers from the river. (12th) Equally. (13th) By land. (14th) Disinfectants. (15th) Yes. (16th) In basins in winter and in streams in summer. (17th) 19 days—ascend, 12; apogee, 2; descent, 5; (18th) No. (19th) No. (20th) 224 attacks—79 males, 145 females. (21st) 29 deaths—8 males, 21 females. (22d) Not observed. (23d) There are none.

*Villavendimio, 618 inhabitants.*—(1st answer.) From the 15th of August to the 12th of September. (2d) A focus formed by the washing of clothing in an infected water reservoir. (3d) First, good; second, bad. (4th) There is none; no public cleaning. (5th) Good spring-water of unknown origin; well-water. (6th) Yes; the water of the reservoir where the washing was done. (7th) Calcareous and clayey; there are three marshes; fevers in autumn and spring. (8th) At 184 meters. (9th) There are none. (10th) That of 1834 greater; that of 1855 less. (11th) There are no rivers nor streams. (13th) Neighboring roads. (14th) Everything. (15th) Use of fruits was prohibited. (16th) Washing in the house. (17th) 28 days; the epidemic was greatest during the first three days. (18th) Yes. (19th) Before, no; during the epidemic, yes. (20th) 108 attacks—35 males, 73 females. (21st) 24 deaths—16 adults, 8 children. (22d) All in the lower; 27 to the north; 61 to the south; 12 to the east; 8 to the west. (23d) There are none.

*Bustillo del Oro, 769 inhabitants.*—(1st answer.) From the 20th to the 28th of September. (2d) By persons. (3d) First, good; second, bad. (4th) Everything wanting. (5th) Good spring-water. (6th) No. (7th) Calcareous and sandy; no marshes nor fevers. (8th) At 90 meters. (9th) A part of cement and part of lead. (10th) No epidemic since 1834. (11th) There are no rivers. (13th) Neighboring roads. (14th) Everything. (15th) Yes. (16th) In the houses. (17th) 9 days—ascend, 2; apogee, 4; descent, 3. (18th) Coincided with descent. (19th) No. (20th) 135 attacks—55 men, 78 women, 2 children. (21st) 13 deaths—5 males, 8 females. (22d) All in the lower. (23d) There are none.

*Cerecinos de Campos, 1,395 inhabitants.*—(1st answer.) From the 25th of September to the 28th of October. (2d) Unknown; suspected by effects. (3d) Both bad. (4th) Everything wanting. (5th) Bad; well-water. (6th) Unknown. (7th) Calcareous and clayey; no marshes nor fevers. (8th) At 1 kilometer. (9th) There is none. (10th) The former greater. (11th) Traversed by a stream. (12th) Equally. (13th) Highways. (14th) Disinfectants. (15th) Yes. (16th) In public lavatories. (17th) 35 days—ascend, 6; apogee, 2; descent, 27. (18th) Yes. (19th) Yes. (20th) 25 attacks—6 males, 19 females. (21st) 11 deaths—2 males, 9 females. (22d) All in the lower. (23d) There are none.

*Fonfría, 1,782 inhabitants.*—(1st answer.) From the 14th of August to the 7th of September. (2d) Imported by persons. (3d) Both bad. (4th) There is none; cleaning by the municipality. (5th) Spring and river water; good; containing magnesia. (6th) No. (7th) Clayey; surrounded by springs. (8th) At 900 meters. (9th) Of brick. (10th) Did not suffer during former epidemics, because of little communication. (11th) A half hour from the river Ebro. (12th) Equally. (13th) Highways. (14th) Cordons. (15th) No. (16th) In the river. (17th) 24 days—ascend, 8; apogee, 8; descent, 13. (18th) Yes. (19th) Yes. (20th) 18 attacks—4 males, 14 females. (21st) 8 deaths—2 males, 6 females. (22d) In the lower; to the north, 10; to the south, 8.



*Fuentes Secas*, 506 inhabitants.—A single case proceeding from an infected place ; the person died in 24 hours.

PROVINCE OF BURGOS.

*Vadocondes*, 884 inhabitants.—(1st answer.) From the 12th of July to the 9th of October. (2d) By a person. (3d) The first, bad; second, good. (4th) There is none ; filth in the high-ways ; no public service. (5th) Used the river Duero water. (7th) Good sand and clay ; no marshes or frequent fevers. (8th) At 500 meters. (10th) That of 1855 the same as this. (11th) Upon the Duero, which flows along two-thirds of the edge of the town. (12th) The part near the river most attacked. (13th) Highway and neighboring roads. (14th) Nothing. (15th) Little. (16th) In the river Duero. (17th) 88 days—ascend, 42 ; apogee, 5 ; descent, 41. (18th) Not noted. (19th) Yes. (20th) 383 attacks. (21st) 40 deaths. (22d) All in the lower ; equally as to winds. (23d) No cases in the post of the Civil Guard.

*Pampliega*, 1,158 inhabitants.—(1st answer.) From the 17th of July to the 28th of August. (2d) By a person. (3d) Both good. (4th) There is none ; no public cleaning ; the filth collected for manure. (5th) From the river Arlanzon ; good ; containing magnesia. (7th) Clay ; intermittent fevers from May to October. (8th) At 200 meters. (9th) There is none. (10th) The former greater. (11th) Adjoining the river Arlanzon. (12th) Equally. (13th) Railways and by land. (14th) Disinfectants. (15th) No. (16th) In the river. (17th) 43 days—ascend, 20 ; apogee, 2 ; descent, 21. (18th) Yes ; with clouds. (19th) No. (20th) 233 attacks—68 men, 105 women, 34 boys, 26 girls. (21st) 37 deaths—20 males, 17 females. (23d) The post of the Civil Guard in the same proportion as the town.

*Palazuelos de Muix*, 284 inhabitants.—(1st answer.) From the 24th of July to the 15th of August. (2d) By persons. (3d) Both good. (4th) There is none ; cleaning by the inhabitants. (5th) Used well-water of unknown origin ; good. (6th) No. (7th) Sand ; there are many streams, and frequent fevers in spring and summer. (8th) Adjoining the village. (9th) There is none. (10th) Deaths in 1834, 2 ; in 1855, 4 ; in 1885, 57. (11th) A river at 1 kilometer from the village, and another at half a kilometer, the Cogollos. (12th) Equally. (13th) Neighboring roads. (14th) Disinfectants. (15th) No. (16th) In the Arlanzon, and each inhabitant his own separately. (17th) 22 days—ascend, 8 ; apogee, 4 ; descent, 10. (18th) Yes. (19th) No. (20th) 170 attacks—75 males, 95 females. (24th) 57 deaths—24 males, 33 females. (23d) All the houses have two stories inhabited ; equally as respects winds. (23d) There are none.

*Santa Cruz de la Salceda*, 845 inhabitants.—(1st answer.) From the 2d of August to the 5th of October. (2d) By persons. (3d) First, good ; second, bad ; little ventilation. (4th) There is none ; cleaning by the inhabitants. (5th) Spring-water of unknown origin ; hard ; containing lime and magnesia. (6th) No. (7th) Clay ; no marshes nor frequent fevers. (8th) At 250 meters. (9th) Unknown. (10th) Less. (11th) Upon a stream, and at its confluence with another. (12th) Equally. (13th) Neighboring roads. (14th) Disinfectants. (15th) Yes. (16th) In the streams ; each family its own. (17th) 65 days—ascend, 20 ; apogee, 23 ; descent, 22. (18th) Yes ; the epidemic began 2 days afterwards. (19th) Yes. (20th) 278 attacks—138 males, 140 females. (21st) 39 deaths—24 males ; 15 females. (22d) 40 in the lower ; 230 in the upper ; 154 to the north ; 97 to the south ; 66 to the east ; 71 to the west. (23d) There are none.

*Renuncio*, 252 inhabitants.—(1st answer.) From the 25th of August to the 8th of September. (2d) By persons. (3d) The second, good. (4th) Nothing. (5th) Well-water of unknown origin ; good. (6th) No. (7th) Good ; clay ; no tendency to fevers. (8th) Within the village. (9th) There is none. (10th) That of 1834 greater. (11th) Upon a stream. (12th) Equally. (13th) Roads. (14th) Disinfectants. (15th) No. (16th) Each family in the stream. (17th) 14 days—ascend, 6 ; descent, 8. (18th) It rained during the last days. (19th) Yes. (20th) 21 attacks. (21st) 4 deaths—3 males, 1 female. (22d) All in the upper ; all deaths to north. (23d) There are none.

*Tórtoles de Esquero*, 978 inhabitants.—(1st answer.) From the 6th of September to the 1st of October. (2d) It is believed by persons. (3d) First, ordinary ; second, fair. (4th) There is none ; cleaning by the inhabitants. (5th) Spring-water ; good ; containing neither

lime nor magnesia. (6th) No. (7th) Calcareous; in a valley; no marshes nor fevers. (8th) At 400 meters. (9th) There is none; the spring flowed into the streams, which they clean. (10th) That of 1855 greater. (11th) The small river Esgueva is at the bottom of the valley, 500 meters from the village. (12th) No appreciable difference. (13th) Bad highways. (14th) All. (15th) No. (16th) In streams with good current, and in the river. (17th) 26 days—ascend, 11; apogee, 6; descent, 9. (18th) Yes; on the day following was the greatest number of attacks. (19th) Yes. (20th) 94 attacks—36 males; 58 females. (21st) 31 deaths—14 males, 17 females. (22d) All in the upper; 24 to the north; 51 to the south. (23d) There are none. (24th) Rare in the same houses; many attacks without communication with others.

*Santibáñez Zarzaguda, 902 inhabitants.*—(1st answer.) From the 12th to the 24th of September. (2d) Suspected by persons. (3d) Both good. (4th) There is none; the inhabitants remove the excrement to their lands. (5th) River-water from a river, which a part of the year, is dry. (6th) Every one used river-water. (7th) Sand and clay; fevers not frequent. (8th) At 125 meters. (9th) There are none. (10th) That of 1855 was greater. (11th) Upon a mill stream. (12th) Equally. (13th) By land. (14th) Disinfectants. (15th) Yes. (16th) In streams; each family its own. (17th) 13 days—ascend 5; apogee, 5; descent, 3. (18th) Coincided with great heat. (19th) Yes. (20th) 28 attacks—12 males, 16 females. (21st) 12 deaths—4 males, 8 females. (22d) 2 in the lower; 24 in the upper; 1 to the north; 27 to the south. (23d) There are none.

*Nava de Roa, 919 inhabitants.*—(1st answer.) From the 20th of September to the 6th of October. (2d) By persons. (3d) First, good; second, bad. (4th) There is none; cleaning by the inhabitants. (5th) Fountain water; each house has a well; all good. (7th) Sandy; there is a marsh at 500 meters; few fevers at different times. (8th) 196 meters. (10th) Always been short. (11th) There is a stream; dry in summer. (12th) Equally. (13th) Highway. (14th) Disinfectants. (15th) No. (16th) In the stream. (17th) 16 days—apogee, 4. (19th) No; especially among the children. (20th) 41 attacks—17 males, 24 females. (21st) 9 deaths. (22d) All in the lower; 16 to the south; 21 to the north.

*Quintanilla Pedro Abarca, 251 inhabitants.*—(1st answer.) From the 22d of September to the 17th of October. (2d) Imported by a female harvester. (3d) Both miserable. (4th) Everything wanted. (5th) Good spring water. (6th) No. (7th) Bad; clay; there are streams, but there are no fevers. (8th) In the village adjoining the church. (9th) There are none. (10th) There are no others. (11th) Near a stream, and traversed by another. (12th) Equally. (13th) Neighboring roads. (14th) Disinfectants. (15th) No. (16th) In the little stream which runs through the village. (17th) 25 days—ascend and apogee, 4; descent, 17. (18th) No. (19th) Yes. (20th) 26 attacks—15 men, 9 women, 2 children. (21st) 7 deaths—5 males, 2 females. (22d) Indifferently. (23d) There are none.

*Valdezate, 718 inhabitants.*—(1st answer.) From the 23d of September to the 20th of October. (2d) By a person. (3d) First, good; second, bad. (4th) There is none; inhabitants remove the filth to the fields for manure. (5th) Spring-water; good. (6th) No. (7th) Sandy and calcareous; no marshes nor fevers. (8th) At 180 meters. (9th) There are none. (10th) Less than this; attributed to the destruction of the grapes by hail, and to want. (11th) Surrounded by streams and valleys. (12th) Equally. (13th) Highways and neighboring roads. (14th) Isolation, disinfectants, and fumigation. (15th) They were lost by hail, and the introduction of other fruits was prohibited. (16th) In the running stream. (17th) 27 days—ascend, 8; apogee, 3; descent, 16. (18th) Yes. (19th) Yes. (20th) 110 attacks—40 men; 60 women, 10 children. (21st) 29 deaths—11 men, 14 women, 4 children. (22d) In bad lower stories. (23d) There are none. (24th) Good regimen saved those who observed it.

#### PROVINCE OF CIUDAD REAL.

*Alcázar de San Juan, 8,728 inhabitants.*—(1st answer.) From the 5th of August to the 22d of September. (2d) Supposed by a person from an infected place. (3d) First, good; second, bad. (4th) There are no sewers; there is no public service; the night soil is collected for manure. (5th) Various wells; saline; containing lime. (6th) No. (7th) Granite and calcareous; no marshes nor frequent fevers. (8th) At 600 meters. (9th) Of iron and brick; the



water is used for washing. (10th) More in 1834 and 1855. (11th) In a dry plain at 7 kilometers from the rivers. (13th) Railways and highways. (14th) Fumigations and disinfectants. (15th) Yes. (16th) In basins and in the houses. (17th) 49 days—ascend, 15; apogee, 10; descent, 24. (18th) No. (19th) Yes. (20th) 366 attacks. (21st) 164 deaths—49 males, 115 females. (22d) The majority in the lower; equal to the north and south. (23d) One death among the civil guard, among 8 attacks; 1 death in the prison, among 22 attacks.

*Pedro Muñoz*, 3,168 inhabitants.—(1st answer.) From the 20th of August to the 9th of October. (2d) By persons. (3d) Both good. (4th) There is none; the inhabitants clean frequently. (5th) Well-water containing lime; good. (6th) Suspected well-water. (7th) Calcareous and clayey; surrounded by marshes; malarial fevers frequent in autumn. (8th) At 500 meters. (9th) There are none. (10th) In 1855, less; no other epidemics. (11th) At 6 kilometers; from the river Zancara. (12th) Equally. (13th) Neighboring roads and highways. (14th) Disinfectants. (15th) Yes; much. (16th) In basins and in the houses. (17th) 42 days—ascend, 18; apogee, 3; descent, 21. (18th) The ascent coincided with heavy rains. (19th) No; on the contrary. (20th) 211 attacks—81 males, 130 females. (21st) 124 deaths—53 males, 71 females. (22d) All in the lower.

*Tomelloso*, 9,154 inhabitants.—(1st answer.) From the 16th of August to the 22d of September. (2d) By a female harvester who ate unripe olives for four days. (3d) Both good. (4th) There is none; the excrement removed in the spring and autumn for manure; the sinks are emptied from time to time. (5th) Well and spring water; good; containing some lime. (6th) No. (7th) In the plain; calcareous; at 8 kilometers from the Guadiana; the marshes and the latter produce fevers in the spring and autumn. (8th) At 1 kilometer. (9th) There are none. (10th) Less. (11th) There are no rivers nor streams very near. (12th) Equally. (13th) By land. (14th) Cordons and disinfectants. (15th) Yes. (16th) In basins and in the houses. (17th) 38 days—ascend, 15; apogee, 3; descent, 20. (18th) The epidemic; yes; in a few days; the mortality, no. (20th) 398 attacks—178 males, 220 females. (21st) 225 deaths—93 males, 132 females. (22d) All in the lower; the majority to the south. (23d) There are none. (24th) The poorer classes suffered the most.

*Argamasilla de Alba*, 2,783 inhabitants.—(1st answer.) From the 5th of August to the 1st of September. (2d) By some harvesters from an infected place. (3d) Both bad. (4th) There is none. (5th) Open wells within the houses; the river Guadiana water for domestic uses and irrigation. (7th) Situated upon the Guadiana; the inhabitants along the banks use the river-water; fevers very frequent. (11th) Situated upon the Guadiana, surrounded by irrigated lands. (12th) The ward which suffered was to the north, near the river. (13th) By land. (14th) Cordons and lazarettos, which were prohibited. (19th) Yes. (20th) 500 attacks. (21st) 105 deaths.

NOTE: *La Solana*.—A single case, followed by death; lasted for 12 hours, without communicating the disease to any one.

#### PROVINCE OF CÁCERES.

*Garganta de Bejar*.—(1st answer.) From the 28th of July to the 18th of September. (2d) Supposed to be imported by a shepherd, an inhabitant of an infected place, who was attacked and died. (3d) Both miserable. (4th) Every public service wanting. (5th) Good spring-water. (6th) No. (7th) Sandy and alluvial; no marshes nor fevers. (8th) At 15 meters from the village. (9th) There is none. (10th) This time more. (11th) Upon a hill and near the sources of the streams. (12th) Equally. (13th) By land. (14th) Hygienic measures of all kinds. (15th) No. (16th) In the streams; each one his own. (17th) 52 days—ascend, 20; apogee, 3; descent, 28. (18th) The first cases coincided with storms, but not the apogee. (19th) No. (20th) 92 attacks—67 males, 25 females. (22d) All the cases in the lower story. (23d) There are none.

#### PROVINCE OF SEVILLA.

*Badalatosá*, 2,598 inhabitants.—(1st answer.) From the 26th of July to the 9th of August. (2d) Unknown. (3d) Both bad. (4th) There is none; cleaning by the municipality. (5th) From the river Genil; during the epidemic they used spring-water of unknown sources which

was scanty in quantity, but of good quality and agreeable ; containing lime. (6th) The river was suspected. (7th) Sandy ; the river Genil surrounds the greater part ; intermittent fevers common. (8th) By the side of the village. (9th) There are none. (10th) Equally. (11th) Upon the river Genil ; at a slight elevation above it. (12th) Equally. (13th) By land. (14th) Disinfectants. (15th) Abuse of fruits and vegetables very frequent. (16th) Usually in the river, but during the epidemic in water from the wells within the houses. (17th) 15 days—ascend, 6 ; apogee, 4 ; descent, 5. (18th) No. (19th) Yes. (20th) 116 attacks—58 males, 58 females. (21st) 56 deaths—21 males, 35 females. (22d) In the lower stories, 70 ; in the upper, 46 ; to the north, 100 ; to the south, 16.

*Herrerias*, 4,508 *inhabitants*.—(1st answer.) From the 10th of August to the 20th of September. (2d) By a female from Puente Gennal. (3d) First, good ; second, bad. (4th) There is none ; cleaning by the municipality. (5th) Good ; spring-water, containing lime. (6th) No. (7th) Limestone ; intermittent fevers in autumn. (8th) Adjoining the village. (9th) Of brick. (10th) Equally. (11th) Traversed by a stream. (12th) Indistinctly. (13th) By land. (14th) Disinfection and isolation. (15th) Prohibited. (16th) In public lavatories with running water from the stream. (17th) 41 days—ascend, 6 ; apogee, 4 ; descent, 31. (18th) No. (19th) Yes ; a month before. (20th) 33 attacks—12 males, 21 females. (22d) All in the lower ; 9 to the north ; 5 to the south ; 70 to the east.

## PROVINCE OF PALENCIA.

*Dueñas*, 3,843 *inhabitants*.—(1st answer.) From the 24th of July to the 5th of September. (2d) It is thought by persons from infected places. (3d) Both bad. (4th) There is none. (5th) From the Castilla Canal ; during the epidemic the use of fountain water was advised. (6th) No. (7th) Clay and limestone ; there are marshes and also fevers in autumn. (8th) Near the village. (9th) There are none. (10th) More this time. (11th) Near the rivers Carrion, Pisuerga, and the Castilla Canal. (12th) The inhabitants of the caves were less attacked ; there were 300. (13th) By river, railroad, and highways. (14th) A general cleaning of the houses and streets ; disinfectants in all the houses of the attacked. (15th) Yes. (16th) In the canal. (17th) 44 days—ascend, 22 ; apogee, 4 ; descent, 18. (18th) Yes ; coincided with rains. (19th) Yes. (20th) 836 attacks—423 males, 413 females. (21st) 114 deaths—51 males, 63 females. (22d) More in the lower. (23d) No cases in the post of the civil guard.

*Reinosa*, 364 *inhabitants*.—(1st answer.) From the 27th of July to the 26th of September. (2d) By effects from infected places. (3d) Both bad. (4th) There is none ; the excrement deposited in sinks in the houses ; no public cleaning. (5th) From the river Pisuerga ; good. (6th) No. (7th) Clay ; no marshes nor fevers. (8th) At 1 kilometer. (9th) There are none. (10th) Less this time. (11th) At a half kilometer from the river Pisuerga. (12th) Equally. (13th) By land. (14th) Disinfectants. (15th) Abuse of vegetables. (16th) In the river. (17th) 62 days—ascend, 25 ; apogee, 10 ; descent, 27. (18th) Yes ; a little afterwards. (19th) Yes. (20th) 127 attacks—57 males, 70 females. (21st) 22 deaths—12 males, 10 females. (22d) 40 to the north ; 30 to the south.

*Magáz*, 593 *inhabitants*.—(1st answer.) From the 31st of July to the 7th of September. (2d) By persons from infected places. (3d) Both ordinary. (4th) There is none ; no one charged with the public cleaning. (5th) From the river Pisuerga ; good. (6th) No. (7th) Clay ; there is a marsh ; the Penuela rises to the north ; fevers in September and October. (8th) At 1 kilometer. (9th) There are none. (10th) Equally. (11th) To the north, and at 1 kilometer from the river Pisuerga. (12th) A third more. (13th) Railways and highways. (14th) Household cleaning and disinfection. (15th) No. (16th) In the river Pisuerga. (17th) 38 days—ascend, 15 ; apogee, 5 ; descent, 18. (18th) Yes ; on the following day. (19th) Yes. (20th) 82 attacks—39 males, 43 females. (21st) 16 deaths—9 males, 7 females. (22d) Lower ; equally to the north and south. (23d) There are none.

*Villalobón*.—(1st answer.) From the 1st of August to the 1st of September. (2d) By communication with the capital, 3 kilometers distant. (3d) Bad. (4th) There is none ; cleaning by the inhabitants. (5th) Well-water containing organic substances and lime. (6th) No. (7th) Clay ; no marshes nor fevers. (8th) At 500 meters. (10th) More. (11th) Upon a



stream. (12th) Equally. (13th) Highways and neighboring roads. (14th) Disinfectants. (15th) Yes; of vegetables. (16th) In the stream and river Carrion, which is located 3 kilometers distant. (17th) 31 days. (18th) No. (19th) Yes. (20th) 10 attacks—3 men, 5 women, 2 children. (21st) 10 deaths—3 men, 5 women, 2 children. (22d) All in the lower; 2 to the north; the rest unknown.

*Tariego*, 615 inhabitants.—(1st answer.) From the 4th of August to the 5th of September. (2d) It is said by use of water from the river Pisuerga; the first case had no communication with suspected persons. (3d) First, good; second, bad. (4th) Wanting. (5th) Used river Pisuerga water; considered bad on account of its turbidity; containing lime and magnesia. (6th) Yes; Pisuerga water. (7th) Clay; no marshes, but fevers are frequent in spring and autumn. (8th) Adjoining the village. (9th) No. (10th) No. (11th) Upon the river Pisuerga. (12th) The upper part the most attacked. (13th) Railway and highway. (14th) Disinfectants. (15th) Yes. (16th) In the river; each family its own. (17th) 32 days—ascend. 13; the rest in regular periods. (18th) Yes. (19th) Intestinal catarrhs frequent. (20th) 115 attacks. (21st) 18 deaths—5 males, 13 females. (22d) In high caves and to the south.

*Vestabillo*, 697 inhabitants.—(1st answer.) From the 12th of August to the 21st of September. (2d) By persons from infected places. (3d) Fair. (4th) There is none; inhabitants clean. (5th) Spring and fountain water. (6th) No. (7th) Upon a hill; no marshes nor fevers. (8th) At 1 kilometer. (9th) There are none. (10th) Equally. (11th) At 1 kilometer from the stream. (12th) The part nearest the stream. (13th) Neighboring roads. (14th) Disinfectants. (15th) Some of fruits. (16th) In the stream. (17th) 40 days—ascend, 15; apogee, 10; descent, 15. (18th) Yes; on the following day. (19th) Yes. (20th) 450 attacks—198 males, 252 females. (21st) 110 deaths—32 males, 78 females. (22d) The lower; 100 to the north; 158 to the south.

*Pedraza de Campos*, 546 inhabitants.—(1st answer.) From the 13th of August to the 24th of September. (2d) It is thought by a person who escaped from the lazaretto of Palencia. (3d) Both good. (4th) There is none; filth deposited in the courts; cleaning by the inhabitants. (5th) Rain-water; collected in receptacles; also well-water. (6th) The water contains the comma bacillus of Koch; and there were good conditions for its development. (7th) Sandy and clayey; no marshes nor fevers. (8th) At 200 meters. (9th) There are none. (10) That of 1835 less. (11th) The river Carrion at 20 kilometers distance. (13th) Highways. (14th) Disinfectants. (15th) No. (16th) In the house. (17th) 42 days. (18th) Decrease in the epidemic coincide with rain. (20th) 220 attacks—110 males, 110 females. (21st) 34 deaths—17 males, 17 females. (22d) Only one story in the house.

*Castrillo de Onielo*, 546 inhabitants.—(1st answer.) From the 13th of August to the 6th of September. (2d) By persons. (3d) Both bad. (4th) Everything wanting. (5th) Bad spring-water. (6th) No. (7th) Granite and rock; no marshes nor fevers. (8th) within the village. (9th) Of iron. (10th) Less. (11th) Two small streams surround the village. (13th) By land. (14th) Disinfectants. (15th) Yes. (16th) in the streams. (17th) 24 days—ascend, 5; apogee, 3; descent, 16. (18th) Yes. (19th) No. (20th) 230 attacks—110 males, 120 females. (21st) 37 deaths—13 males, 24 females.

*Ampudia*, 1,445 inhabitants.—(1st answer.) From the 25th of August to the 14th of September. (2d) By persons from infected places. (3d) The first, fair; second, good. (4th) There is none; deposited in the court-yards until October, when it is carried to the fields. (5th) Good spring-water. (6th) No. (7th) Clay; no marshes nor fevers. (8th) At 500 meters. (9th) Of brick. (10th) Less this time. (11th) Traversed by a stream, which drains the fountains. (12th) The part next the river most. (13th) Neighboring roads. (14th) Disinfectants. (15th) Abuse of fruits and vegetables. (16th) In private basins; in the house and in the public lavatories. (17th) 20 days—ascend, 5; apogee, 4; descent, 11. (18th) Yes. (19th) Yes. (20th) 89 attacks—37 males, 52 females. (22d) 9 per cent. inhabit the upper stories. (23d) Same in the post of the Civil Guard as in the town.

*Valoria de Alcor*, 392 inhabitants.—(1st answer.) From the 16th of August to the 29th of September. (2d) By persons from infected places. (3d) Both good. (4th) There is none. (5th) Spring-water, containing lime. (6th) No. (7th) Sandy; 2 small marshes; no fevers.

(8th) Near. (9th) There are none. (10th) In 1835 more, and in 1855 less. (11th) On a hill. (13th) By land. (14th) Fumigations with aromatic plants and with sulphur disinfectants. (15th) Predominance of vegetables. (16th) In the streams and in the houses. (17th) 45 days. (18th) Yes. (19th) Yes. (20th) 28 attacks—12 males, 16 females. (21st) 9 deaths—3 males, 6 females.

*Revilla de Campos*, 189 *inhabitants*.—(1st answer.) From the 21st of August to the 11th of September. (2d) By water from an infected place. (3d) First good; second bad. (4th) Everything wanting. (5th) Well and spring; insects in the one and saline substances in the other. (6th) The first cases were contaminated by infected water. (7th) Silicia and sandy; surrounded by marshes; in the middle of the village there is a pond; fevers in summer. (8th) At 100 meters. (9th) There is none. (10th) Less this time. (11th) No. (12th) Equally. (13th) By land. (14th) Disinfectants. (15th) No. (16th) In pools and well-water in the houses. (17th) 22 days—ascend, 8; apogee, 5; descent, 9. (18th) No. (19th) Yes. (20th) 131 attacks—55 males, 76 females. (21st) 23 deaths—8 males, 15 females. (22d) All of the houses are of one story.

*Alba de Cerrato*, 404 *inhabitants*.—(1st answer.) From the 27th of August to the 4th of October. (2d) By a person. (3d) The first good; second bad; they live in caves, without light or ventilation. (4th) Nothing. (5th) Good spring water. (6th) No. (7th) Calcareous; clayey; no marshes nor fevers. (8th) At 400 meters. (9th) There is none. (10th) Less. (11th) At 500 meters from a stream. (12th) The upper part suffered most. (13th) Neighboring roads and highways. (14th) Disinfectants. (15th) Yes. (16th) In the stream; each person. (17th) 39 days—ascend and descent, 15; apogee, 9. (18th) Yes. (19th) Yes. (20th) 30 attacks—male majority. (21st) 7 deaths—3 males, 4 females. (22d) Almost all in the upper.

*Husillos*, 409 *inhabitants*.—(1st answer.) From the 31st of August to the 23d of September. (2d) By persons from infected places. (3d) The first fair; second miserable. (4th) Everything wanting. (5th) From the river; contains organic substances; clothing is washed in it. (6th) No. (7th) Clay and silicious material; surrounded by marshes; fevers in autumn. (8th) At 600 meters. (9th) There is none. (10th) More in 1854 and 1855. (11th) Upon the river Carrion. (12th) Equally. (13th) Railway and roads. (14th) Disinfectants. (15th) Abuse of fruits, vegetables, and salads. (16th) In the river. (17th) 24 days. (18th) Yes; within 24 hours. (19th) Yes. (20th) 70 attacks—24 males, 46 females. (21st) 9 deaths—2 males, 7 females. (22d) All in the lower.

*Santillana*, 338 *inhabitants*.—(1st answer.) From the 8th of September to the 14th of October. (2d) By persons. (3d) Both ordinary. (4th) There is none; cleaning by the inhabitants. (5th) Good spring water. (6th) Yes. (7th) Clay; calcareous; there are marshes, but no fevers. (8th) Within the village. (9th) There is none. (10th) More. (11th) In a dry place. (13th) By land. (14th) Disinfectants. (15th) No. (16th) In public lavatories; each person. (17th) 36 days—irregular march. (18th) Unknown. (19th) Yes; every summer. (20th) 5 attacks—2 males, 3 females. (21st) 3 deaths—1 male, 2 females. (22d) 2 in the lower; 3 in the upper. (23d) There are none.

*Villamediana*, 987 *inhabitants*.—(1st answer.) From the 27th of September to the 10th of October. (2d) Contagion suspected. (3d) Both bad. (4th) Nothing. (5th) Four springs; good quality. (6th) No. (7th) No marshes nor fevers. (8th) Within the village. (9th) There is none. (11th) Upon a stream. (12th) Equally. (13th) Bad rural roads. (14th) Disinfectants. (15th) No. (16th) The poor in the stream and in the river at 1 league. (17th) 14 days—ascend, 3; apogee, 11. (18th) Yes. (19th) Yes. (20th) 18 attacks—10 males, 8 females. (21st) 5 deaths—2 males, 3 females. (22d) The majority in the lower. (23d) There are none.

*Grijota*, 1,800 *inhabitants*.—(1st answer.) From the 2d to the 29th of September. (2d) By persons from infected places. (5th) From the Castilla Canal; during the epidemic some used fountain water. (7th) Soil and subsoil arid; little vegetation. (8th) The cemetery within the village. (9th) There is none. (10th) Less. (12th) Most of the attacks in the lower part and along the canal. (14th) Isolation and disinfection. (17th) 27 days. (18th) The epidemic



coincided with rains. (20th) 11 attacks. (21st) 4 deaths. (24th) The cholera was introduced by ties of relation and friendship.

*Palencia*, 14,500 *inhabitants*.—(1st answer.) From the 14th of July to the 10th of September. (2d) Unknown; daily attacks followed the first case; afterwards periodically. (3d) Both bad. (4th) Deficient sewers; want of declivity; sinks. (5th) Spring water collected in reservoirs; also from the river Carrion. (6th) The use of the river water was at once toxic. (7th) Silicious soil; subsoil clay; great dryness; scarce vegetation at that season. (9th) Of brick and iron. (10th) This time more. (12th) Upon the left bank of the river Carrion. (12th) The part near the river suffered most, and the first cases were in that quarter. (13th) Railway and roads. (14th) Fumigations, hygienic measures, disinfection of the infected houses, as also of the clothing. (15th) Yes. (16th) In the river, and during the epidemic washing was required to be down stream without regard to the villages situated along the river. (17th) 58 days. (18th) The epidemic increased twice with storms and rains. (19th) Yes. (20th) 145 attacks. (21st) 95 deaths; in the month of December last there were 3 deaths more. (24th) No village up stream was previously invaded; Duenas and Villa Muriel were attacked after Palencia.

*Antigüedad*, 1,006 *inhabitants*.—(1st answer.) From the 1st of September to the 13th of October. (2d) By bags of coal from the capital, an infected point, or by persons who brought them. (3d) Both bad. (4th) Nothing; the drainage into the square and court-yards. (5th) Spring water containing lime. (7th) Soil calcareous and dry. (9th) There is none. (14th) Nothing. (17th) 43 days. (19th) Yes; considerable diarrhoea and colic. (20th) 200 attacks. (21st) 32 deaths. (24th) In the month of December, 6 degrees below zero, there were 6 attacks to which a mother and daughter fell victims to the latent germs of cholera.

#### PROVINCE OF SEGOVIA.

*Domingo García*, 273 *inhabitants*.—(1st answer.) From the 6th of August to the 8th of September. (2d) Unknown. (3d) Both good. (4th) There is none; cleaning by the municipality. (5th) Good spring water; collected in fountains; containing magnesia. (6th) No. (7th) Rocky; no marshes nor fevers, except a few in the spring. (8th) At 160 meters. (9th) Of brick. (10th) Equally. (11th) No river; but there are insignificant streams. (12th) In the center of the village. (13th) By land. (14th) Disinfectants. (15th) Yes. (16th) In private basins outside of the houses. (17th) 33 days—ascend, 14; descent, 19. (18th) Yes. (19th) Yes. (20th) 24 attacks—14 males, 10 females. (21st) 16 deaths—9 males, 7 females. (22d) All in the lower; to the south, 10; to the north, 6.

*Mozoncillo*, 1,018 *inhabitants*.—(1st answer.) From the 13th to the 26th of August. (2d) Unknown; first case a very poor shepherd, who drank after a heavy storm unhealthy stagnant water. (3d) Both bad. (4th) There are no sewers nor public service; inhabitants clean. (5th) Well water of medium quality. (6th) No; but the greater part of the persons attacked drank stagnant water in the fields like the shepherd. (7th) Clay; damp; near marshes; fevers excessive the whole year. (8th) In the village adjoining the church. (9th) There is none. (10th) More. (11th) Between a river and stream which traverses the village. (12th) All the cases, except one, near the river and stream. (13th) Neighboring roads. (14th) Disinfectants. (15) Yes. (16th) In the river and the streams. (17th) 13 days. (18th) Yes. (19th) Yes. (20th) 40 attacks—22 males, 18 females. (21st) 7 deaths—3 males, 4 females. (22d) All in the lower; to the south, 27; to the north, 6.

*Mata de Cuéllar*, 405 *inhabitants*.—(1st answer.) From the 29th of August to the 1st of October. (2d) Unknown. (3d) First, ordinary; second, good. (4th) There is none; the cleaning directed by the board of health during the epidemic. (5th) Supplied from the river; during the cholera used water from a spring near the river. (6th) No. (7th) Sandy; surrounded by ponds; fevers not frequent. (8th) In the village. (9th) There is none. (10th) More. (11th) On the bank of the stream at 1 kilometer from the river. (12th) Equally. (13th) Neighboring roads and highways. (14th) Isolation and fumigations. (15th) No. (16th) In the river at 1 kilometer. (17th) 34 days. (18th) Yes. (19th) Yes. (20th) 6

attacks—2 males, 4 females. (21st) 4 deaths—2 males, 2 females. (22d) All in the lower; to the north, 2; to the south, 2. (24th) It is thought that storms brought the cholera.

*Calabazas, 234 inhabitants.*—(1st answer.) From the 3d to the 28th of September. (2d) Unknown. (3d) Ordinary. (4th) There is none; cleaning by the inhabitants. (5th) Springs; soft; containing lime and magnesia. (6th) No. (7th) Granite; calcareous; no marshes nor frequent fevers. (8th) At 500 meters. (9th) There is none. (10th) As in this. (11th) There is neither river nor stream. (13th) By land. (14th) Disinfectants. (16th) Each one in the public lavatory. (17th) 25 days—ascend, 9; apogee, 5; descent, 11. (18th) Yes. (19th) Yes. (20th) 31 attacks—14 males, 17 females. (21st) 12 deaths—7 males, 5 females. (22d) All in the lower; to the south, 20; to the north, 11. (23d) There are none.

*Carbonero el Mayor, 1,952 inhabitants.*—(1st answer.) From the 5th of September to the 15th of October. (2d) Unknown. (3d) First bad; second miserable. (4th) There is none; no public cleaning; the excrement used for manure. (5th) Spring water; some good; others fair. (6th) No. (7th) Clay; calcareous; no marshes nor fevers. (8th) At 200 meters. (9th) Of brick. (10th) Less. (11th) Between two rivers, at 3 kilometers. (12th) Equally. (13th) Highways. (14th) Disinfectants. (15th) Yes. (16th) In one of the rivers. (17th) 40 days. (18th) Yes. (19th) Yes. (20th) 40 attacks—2 males, 38 females. (21st) 17 deaths—2 males, 15 females. (22d) All in the lower. (24th) The cholera attributed to excess of fruits.

*Cantalejo, 1,690 inhabitants.*—(1st answer.) From the 1st of August to the 1st of October. (2d) Unknown. (3d) First good; second miserable. (4th) There is none; filth deposited in the court-yards, and the dirty water in the streets. (5th) Well water. (6th) Suspected well water. (7th) Soil, sandy; subsoil, clayey; very dry; streets badly ventilated; situated at 985 meters above the level of the sea. (9th) There is none. (10th) No attack in 1834 or 1855. (11th) Distant from the river. (12th) The lower part was considerably invaded. (13th) Very bad roads. (14th) No preventive measures taken. (15th) Much abuse of alcohol. (16th) General washing of clothing in public lavatories, but in boiled water. (17th) 61 days—ascend, 26; apogee, 8; descent, 27. (18th) The invasion coincided with heavy rains; a focus occasioning various victims in the same family was produced during the first days. (20th) 243 attacks. (21st) 53 deaths. (23d) There is none. (24th) Particularly the weak were attacked; the poor in bad hygienic circumstances.

#### PROVINCE OF SORIA.

*Chaorna, 322 inhabitants.*—(1st answer.) From the 19th of July to the 14th of August. (2d) Unknown; in the village there is a river which flows into the Jalon; there is communication between the village and infected places. (3d) Both bad. (4th) There is none; inhabitants clean. (5th) Good spring water. (6th) No. (7th) Gravelly; calcareous; damp; fevers during the year when the stream is dry. (8th) The first cases in the old in the village; another was established at 400 meters. (9th) There is none. (10th) There were no others. (11th) On the bank of the stream. (12th) The part next the river suffered most. (13th) Railways and highways. (14th) All. (15th) Yes. (16th) In the stream. (17th) 26 days—ascend, 9; apogee, 4; descent, 13. (18th) No; only fogs from the Jalon, which was infected. (19th) No. (20th) 34 attacks—10 males, 24 females. (21st) 16 deaths—3 males, 13 females. (22d) 25 in the upper; 9 in the lower; equally to the north and south. (24th) Hygiene wanting.

*San Estéban de Gormaz, 1,590 inhabitants.*—(1st answer.) From the 18th of August to the 13th of September. (2d) It is thought by the atmosphere. (3d) First good; second ordinary. (4th) There is none; cleaning by the municipality. (5th) Very good; proceeding from the Duero. (6th) No. (7th) Sandy; calcareous; clayey; no marshes nor frequent fevers. (8th) Near the village. (9th) There is none. (10th) Deaths equal. (11th) Upon the Duero. (12th) Less; near the river. (13th) Neighboring roads. (14th) All. (15th) No. (16th) In the Duero. (17th) About a month. (18th) No. (19th) Yes. (20th) 110 attacks—37 males, 73 females. (21st) 17 deaths—3 males, 14 females. (22d) All in the lower. (23d) There are none.

*Almarail, 138 inhabitants.*—(1st answer.) From the 11th of August to the 2d of September. (2d) By persons. (3d) First bad. (4th) Each house a collection of filth. (5th) The



river Duero water is used; generally good, except during storms, when it is bad. (6th) No. (7th) Sandy; there are fevers on account of the river, which surrounds the village, and which carries decomposed organic substances. (8th) In the village. (10th) The same. (11th) Upon a stream. (12th) By two persons. (13th) By land. (14th) Disinfectants. (15th) No. (16th) In the river near the village. (17th) 22 days—ascend, 11; apogee, 3; descent, 8. (18th) No. (19th) Yes. (20th) 14 attacks—7 males, 7 females. (21st) 8 deaths—3 males, 5 females.

*Urtilla*, 700 inhabitants.—(1st answer.) From the 20th of August to the 16th of September. (2d) Unknown. (3d) First, good; second, bad. (4th) There is none; no public cleaning. (5th) Good fountain water. (6th) No. (7th) Clay; no marshes; few fevers. (8th) 2; at 600 meters. (9th) There is none. (10th) Equally. (11th) Upon the stream Margon. (12th) Not observed. (13th) Highways. (14th) Disinfectants. (15th) No. (16th) In the public lavatory and streams. (17th) 27 days—ascend, 10; apogee, 4; descent, 13. (18th) No. (19th) Yes. (20th) 12 attacks—4 males, 8 females. (21st) 7 deaths—3 males, 4 females. (22d) 8 in the lower; 4 in the upper. (23d) There are none.

*Lama*, 594 inhabitants.—(1st answer.) From the 20th to the 30th of August. (2d) Spontaneous. (3) Both ordinary. (4th) There is none; filth removed by an inhabitant. (5th) Spring water; good; hard; containing lime. (6th) No. (7th) Calcareous, clayey; no marshes nor fevers. (8th) At 80 meters. (9th) Of brick. (10th) This time more. (11th) At 120 meters from the stream Blanco. (12th) Equally. (13th) Highways and railways. (14th) All three. (15th) No. (16th) In the stream and in the houses. (17th) 11 days. (18th) 22 days afterwards. (19th) Yes. (20th) 9 attacks—7 males, 2 females. (22d) All in the upper and to the south.

#### PROVINCE OF NAVARRA.

*Tudela*, 10,086 inhabitants.—(1st answer.) From the 24th of July to the 30th of September. (2d) It is thought by a person. (3d) The first fair; second bad. (4th) Sewers only for rain-water; the inhabitants clean. (5th) The river Ebro water. (6th) No. (7th) Sand and clay; there is a marsh and a pool; some fevers. (8th) At 300 meters. (9th) There is none. (10th) That of 1834 more. (11th) Upon two streams and near the Ebro. (12th) The poorest and the dirtiest quarter is near the stream; it suffered most. (13th) By rail and highways. (14th) Lazarettos, disinfection, and cleaning. (15th) Yes. (16th) In the neighboring streams from the springs. (17th) 68 days—ascend, 30; apogee, 4; descent, 34. (18th) Yes. (19th) Yes. (20th) 832 attacks—353 males, 479 females. (21st) 352 deaths—136 males, 216 females. (22d) Equally. (23d) The quarters of the cavalry, the hospital, and the prison; nothing noteworthy; after the epidemic there was a case among the civil guard.

*Allo*, 1,119 inhabitants.—(1st answer.) From the 17th of July to the 4th of September. (2d) Unknown. (3d) Both ordinary; excess of inhabitants in the houses. (4th) There is none; cleaning by the inhabitants. (5th) Springs of unknown origin; the water conducted by pipes; good; containing lime. (6th) No. (7th) Sand and clay; no marshes nor fevers. (8th) At 700 meters. (9th) 120 meters of brick. (10th) That of 1834 greater; that of 1855 short. (11th) At 4 kilometers from the river Ega. (12th) Equally. (13th) By land. (14th) Cordons and disinfectants. (15th) Yes. (16th) In public lavatories; in the river and lately in the stream. (17th) 51 days—ascend, 18; apogee, 3; descent, 30. (19th) Yes. (20th) 142 attacks—36 males, 106 females. (21st) 41 deaths—9 males, 32 females. (22d) In the upper; equally to the north and south. (23d) There are none.

*Marchante*, 1,415 inhabitants.—(1st answer.) From the 28th of July to the 5th of September. (2d) By persons. (3d) First good; second very bad. (4th) There is none; excrement collected for the manure for the fields; cleaning by the municipality. (5th) Fountain water, which is united with bad spring water; bad and scarce. (6th) Usually the above water. (7th) Calcareous; there is a marsh which is a focus for malaria. (8th) At 1 kilometer. (9th) There is none. (10th) The former less severe. (11th) In the river or stream. (13th) Highways. (14th) All. (15th) Yes. (16th) Each inhabitant in his house. (17th) 39 days—ascend, 17; apogee, 5; descent, 17. (18th) No. (19th) No. (20th) 471 attacks. (21st) 99 deaths—35 males;

64 females. (22d) Unknown. (23d) There is none. (24th) The physician believes that the pool or the marsh is the cause of all the disease.

*Oscoz, 957 inhabitants.*—(1st answer.) From the 30th of July to the 2d of September. (2d) Unknown. (3d) Both good. (4th) There is none; cleaning by the inhabitants. (5th) Spring water; good. (6th) No. (7th) Granite; no marshes; fevers unknown. (8th) At 800 meters. (9th) There is none. (10th) More in the former; unknown why. (11th) Upon a stream. (12th) A fifth more in the part near the stream. (13th) By land. (14th) Disinfectants. (15th) No. (16th) In public lavatories. (17th) 33 days—ascend, 16; apogee, 3; descent, 14. (18th) Yes. (19th) Yes. (20th) 84 attacks—40 males, 44 females. (21st) 13 deaths—8 males, 5 females. (22d) All in the lower; equally to the north and south. (23d) There are none.

*Iza, 953 inhabitants.*—(1st answer.) From the 30th of July, with a cessation of two months; afterwards from the 1st of October to the 10th of November. (2d) By persons. (3d) Both fair. (4th) Everything wanting. (5th) Good spring water. (6th) No. (7th) Granite and clay; no marshes nor fevers. (8th) At 400 meters. (9th) There is none. (10th) Almost equal. (11th) Two of the invaded wards are located upon a stream. (12th) Equally. (13th) Neighboring roads. (14th) Isolation and disinfectants. (15th) No. (16th) Some in streams; others in pools distant from the village. (17th) In three wards the disease lasted: in the first, 8; in the second, 20; and in the third, 15 days, with irregular march. (18th) During the development of the cholera in October it snowed. (19th) Unknown. (20th) 25 attacks—13 males, 12 females. (21st) 10 deaths—3 males, 7 females. (22d) All in the lower, and equally as respects to winds. (23d) There are none.

*Ucar, 434 inhabitants.*—(1st answer.) From the 3d of August to 5th of September. (2d) Unknown. (3d) Both miserable. (4th) There is none; no public cleaning. (5th) Spring water; good, but scarce. (6th) No. (7th) Clay; no marshes nor fevers. (8th) At 300 meters. (9th) There is none. (10th) That of 1855 greater. (11th) Upon a small stream. (12th) Equally. (13th) Neighboring roads. (14th) Disinfectants. (15th) No; only salads. (16th) In the public lavatory. (17th) 34 days—ascend, 18; apogee, 5; descent, 11. (18th) No. (19th) No. (20th) 40 attacks—13 men, 16 women, 11 children. (21st) 7 deaths—4 men, 1 woman, 2 children. (22d) All in the upper; almost equally to the north, south, east and west. (23d) There are none.

*Eneriz, 474 inhabitants.*—(1st answer.) From the 3d of August to the 5th of September. (2d) Unknown. (3d) First, bad; second, good. (4th) There is none; inhabitants clean. (5th) Good spring water and fair fountain water. (6th) No. (7th) Clay; no marshes nor fevers. (8th) At 300 meters. (9th) There is none. (10th) That of 1855 greater. (11th) Upon a stream which traverses the village. (12th) No difference noted. (13th) Neighboring roads. (14th) Disinfectants. (15th) No. (16th) In the public lavatory and in the stream. (17th) 34 days—ascend, 17; apogee, 3; descent, 14. (18th) No. (19th) No. (20th) 35 attacks—10 men, 18 women, 7 children. (21st) 7 deaths—1 male, 6 females. (22d) All in the upper. (23d) There are none.

*Mendigorría, 2,117 inhabitants.*—(1st answer.) From the 7th of August to the 7th of September. (2d) Unknown. (3d) First, good; second, bad. (4th) There is none; cleaning by the inhabitants. (5th) Water from the river Arga. (6th) No. (7th) Clay; no marshes nor fevers; good climatic conditions. (8th) At 500 meters. (9th) The water carried from the river by horses. (10th) That of 1855 had triple the number of attacks, and lasted three times as long. (11th) There are two rivers and several streams near the village. (12th) Lazarettos, and disinfectants on a large scale. (15th) Yes. (16th) In the river. (17th) 31 days—ascend, 10; apogee, 5; descent, 16. (18th) No. (19th) Yes. (20th) 290 attacks—136 males, 154 females. (21st) 77 deaths—35 males, 42 females. (22d) In the lower. (24th) Many fulminant cases; lasting from 3 to 12 hours.

*Monteagudo, 1,000 inhabitants.*—(1st answer.) From the 7th of August to the 1st of September. (2d) Neither by persons nor effects. (3d) Both good. (4th) There is none; cleaning left to the inhabitants. (5th) Good spring-water. (6th) No. (7th) Good; clayey and calcareous; no fevers. (8th) At 200 meters. (9th) Of brick. (10th) That of 1855 same as this; the others less. (11th) The upper part surrounded by canals and streams. (12th) In the



street nearest the canal the mortality was a third greater. (13th) Highways. (14th) All. (15th) Yes; of all. (16th) In streams. (17th) 26 days—ascend, 10; apogee, 4; descent, 12. (18th) No. (19th) Yes. (20th) 85 attacks—37 males, 48 females. (21st) 28 deaths—7 males, 21 females. (22d) 5 in the lower; 80 in the upper; equally towards the winds. (23d) There are none. (24th) Those using good and bad food equally attacked.

*Caparroso*, 1,872 inhabitants.—(1st answer.) From the 10th of August to the 3d of September. (2d) Imported by a healthy person from an infected place; several cases occurred simultaneously. (3d) Both very bad; streets narrow and dirty. (4th) There is none; each house is a deposit of filth, and many of them constitute Noah's ark. (5th) Water from the river; some preserve it in large earthen jars; others use well water; 30 meters distant from the river. (6th) Suspected. (7th) Mountainous land; soil sandy; subsoil clayey; no marshes nor stagnant pools; no malarial fevers. (11th) Situated upon the left margin of the river Aragon. (13th) By land. (14th) Cordons and lazarettos before the epidemic; only hygienic measures afterwards. (15th) Yes. (16th) Washing in the river. (17th) 24 days. (18th) Coincided with tempest and rain. (19th) Was preceded by diarrheas and intestinal disturbances. (20th) 161 attacks—71 males, 90 females. (21st) 21 deaths—9 males, 12 females. (24th) At the same time the cholera began in this village it appeared in Mellida, and two days afterwards in Carcastillo; villages situated up stream.

*Estella*, 6,749 inhabitants.—(1st answer.) From the 19th of August to the 12th of October; 8 days passed without attacks. (2d) Unknown; but various villages up stream were attacked previously. (4th) There is none; the drainage is removed from the sinks in vessels and thrown into the river beyond the village. (5th) The river Amescua water is used, but when the cholera appeared in Echavarri, situated upon the same river, they used water from fountains which were not suspected. (6th) Yes. (7th) Subsoil clay; damp. (9th) There is none. (11th) On the banks of the river Ega, which divides the town into two parts. (13th) By land. (14th) Cordons, lazarettos before the epidemic was officially declared, and afterwards isolation, disinfectants and destruction of the clothing of the attacked. (17th) After the 9th of September, 33 days—ascend, 15; apogee, 3; descent, 15. (18th) Apogee coincided with heavy rains. (20th) 119 attacks—46 males, 73 females. (21st) 43 deaths. (24th) The first case did not give rise to the development of the epidemic, for more than 8 days of interval passed.

*Andosilla*, 1,769 inhabitants.—(1st answer.) From the 9th of August to the 2d of September. (2d) Imported from Falos, an infected village; it was propagated immediately, as there were new cases on the following days. (4th) There is none; the excrement removed to the public streets. (5th) Used the river Ega water. (6th) Yes. (7th) Slight limestone and part clay. (9th) There is none. (11th) On the banks of the Ega. (12th) The upper part, in the best condition, suffered most. (14th) Fumigations; an observation for 3 to 5 days, and fumigation during the night with sulphur. (20th) 126 attacks. (21st) 68 deaths.

*Beasoain (Valle del Olla)*.—(1st answer.) From the 8th to the 16th of August. (2d) It is thought by a person. (3d) Both good. (4th) There is none; the public cleaning is good. (5th) Water from an adjacent river; good. (6th) Unknown. (7th) Clay; limestone; no marshes nor fevers. (8th) At 200 meters; it serves for two villages, Beasoain and Eguilior; the last village had no case. (10th) The former epidemic did not reach this town. (11th) Upon the river Erge and 20 meters above it. (12th) Equally. (13th) By land. (14th) Cordons and disinfectants. (15th) No healthy food. (16th) In the river after rinsing them in the house. (17th) No observations made. (18th) No. (19th) No. (20th) 63 attacks—12 children, 44 adults, 7 aged. (21st) 21 deaths—7 men, 11 adult, 3 aged. (22d) There were 63 attacked of the 66 houses which the village contains.

*Mendavia*, 2,552 inhabitants.—(1st answer.) From the 10th of August to the 12th of September. (2d) By a person. (3) Bad. (4th) Everything wanting. (5th) Used the Ebro water; good. (6th) No. (7th) Sandy; surrounded by irrigated land; frequent fevers in spring and autumn. (8th) At 150 meters; there was another erected at 1 kilometer during the epidemic. (9th) There is none. (10th) The former less. (11th) Upon a river which rises in the mountain at 2 kilometers from the Ebro. Canals traverse the village. (12th) Equally. (13th) Highways. (14th) All. (15th) Yes. (16th) In the rivers. (17th) 33 days—ascend, 12;

apogee, 9; descent, 12. (18th) No. (19th) No. (20th) 615 attacks—266 males, 349 females. (21st) 95 deaths—44 males, 51 females.

*Lumbier, 2,228 inhabitants.*—(1st answer.) From the 11th of August to the 19th of September. (2d) Imported by effects. (3d) First good, second bad. (3d) Only one street contains a sewer; cleaning by the inhabitants. (5th) Water from the rivers Salazar and Irasti. They proceed from the Pyrenees. (6th) No. (7th) Calcareous soil; no marshes nor fevers. (8th) At 400 to 500 meters. (9th) There is none. (10th) More in the two former. (11th) At the confluence of the two rivers Salazar and Irasti. (12th) The part near the river suffered a third more. (13th) Highways. (14th) All. (15th) No; good food. (16th) In rivers. (17th) 40 days—ascend, 20; apogee, 10; descent, 10. (18th) No. (19th) Yes. (20th) 296 attacks—130 males, 166 females. (21st) 51 deaths—21 males, 30 females. (22d) All in the upper; majority to the south. (23d) There are none.

*Marcilla, 597 inhabitants.*—(1st answer.) From the 1st to the 19th of August. (2d) It is thought by drinking water from the river Aragon. (3d) First good, second bad. (4th) There is none; the night soil is emptied into the court-yards and into the streets; there is no public cleaning. (5th) Water from the river Aragon, and from a well which filtrates from the same. River water, good. (6th) Yes; by the river water. (7th) Detritus; tertiary clay; no marshes; rare fevers. (8th) At 105 meters. (9th) There is none. (10th) Deaths in 1834, 37; in 1855, 30; in 1885, 9. (11th) Surrounded by canals and streams, and at one kilometer from the river Aragon. (12th) The river is the same distance from the whole village. (13th) Railway and neighboring roads. (14th) All except cordons. (15th) Yes. (16th) In the streams near the village. (17th) 18 days—ascend, 6; apogee, 3; descent, 9. (18th) No. (19th) Yes. (20th) 35 attacks. (21st) 9 deaths. (22d) Equally.

*Tafalla, 6,040 inhabitants.*—(1st answer.) From the 12th of August to the 6th of September. (2d) Imported by a person. (3d) First, good; second, bad. (4th) There are sewers constructed of laid stone; they empty into the river; the municipality cleans. (5th) In the winter they use water from the river Cidacos; good; in summer this is bad, and water is taken from a fountain. (6th) No. (7th) Clay; no marshes nor fevers. (8th) At 3 kilometers. (9th) There is none. (10th) That of 1834 was short; that of 1855 gave 1,000 deaths among 4,000 inhabitants. This was attributed to the ancient and crowded cemetery within the town. (11th) By the river Cadaco. (12th) Equally. (13th) Railway and highways. (14th) Isolation and disinfectants. (15th) No. (16th) In the public lavatory; usually each had one in his own house. (17th) 26 days; equal march. (18th) No. (19th) Unknown. (20th) 16 attacks—8 males, 8 females. (21st) 9 deaths—4 males, 5 females. (22d) All in the upper; 3 to the north, 4 to the south, 3 to the east, 6 to the west. (23d) In the post of the civil guard, there was no case.

*Villafranca, 3,086 inhabitants.*—(1st answer.) From the 13th of August to the 10th of September. (2d) By a person. (3d) Both bad. (4th) There is none; the municipality cleans. (5th) Use of the water of the river Aragon was prohibited during the epidemic, when water was used from two wells. (6th) Yes; by washing the clothing in the river and drinking its water. (7th) Alluvial soil; irrigated lands surrounded the village; there are fevers in spring and autumn. (8th) At 500 meters. (9th) There is none. (10th) That of 1855 was much greater. (11th) At the confluence of the rivers Arga and Aragon. (12th) It began in the lower part, but the part beyond suffered the most. (13th) Highway and neighboring roads. (14th) All. (15th) Yes. (16th) In the streams and in fixed places. (17th) From 26 to 28 days in two periods; the first very marked; the second declining. (18th) Yes. (19th) Yes. (20th) 140 attacks. (21st) 45 deaths. (22d) Almost all in the upper; equally to the north and south. (23d) There are none. (24th) Especially attacked pregnant women.

*Lodosa, 2,200 inhabitants.*—(1st answer.) From the 17th of August to the 11th of September. (2d) It is thought by the water of the river Ebro. (3d) The first fair; the second bad. (4th) There is none; by the municipality. (5th) From the Ebro, considered good. (6th) The majority used Ebro water; others well water. (7th) Near the Ebro; there are fevers the whole year round, and many in autumn. (8th) Within the village; at the commencement of the cholera, another was located at 1,000 meters. (9th) There is none. (10th) That of 1855 was



short; they used the Ebro water; this time they preferred water of wells filtrated from the Ebro. (11th) At 100 meters from the river. (12th) The part near the river suffered less. (13th) Railways and neighboring roads. (14th) All. (15th) Yes. (16th) The clothing collected in the houses, and washed in the Ebro. (17th) 24 days—ascend, 8; apogee, 7; descent, 9. (18th) No; the greatest mortality coincided with heat. (19th) Yes. (20th) 232 attacks—132 males, 100 females. (21st) 40 deaths—12 children, 15 aged, 13 adults. (22d) All in the lower. (23d) There are none.

*Murillo de Fruto, 751 inhabitants.*—(1st answer.) From the 18th to the 29th of August. (2d) By a person. (3d) Both bad. (4th) There is none; cleaning by the inhabitants. (5th) Water from the river Aragon; good. (6th) No. (7th) Clay and calcareous; much irrigated land; there were formerly fevers; there are few to-day, and at no fixed period. (8th) At 200 meters. (9th) There is none. (10th) This time less. (11th) Near the river. (12th) The part removed from the river suffered most. (13th) Neighboring roads. (14th) Cordons and disinfectants. (15th) Yes. (16th) In the river Aragon. (17th) Official dates, 12 days; there were cases 15 days before. (18th) Not observed. (19th) Yes. (20th) 16 attacks—6 males, 10 females. (21st) 3 deaths—1 male, 2 females. (22d) 2 in the lower, the rest in the upper. (23d) There are none.

*Fitero, 3,013 inhabitants.*—(1st answer.) From the 19th of August to the 28th of September. (2d) By a person. (3d) The first fair, the second good. (4th) There is a sewer only in one street; the rest of the filth deposited in the court-yards; there is no public cleaning. (5th) River, spring, and rain-water; all bad. (6th) No. (7th) Calcareous clay; it is surrounded by numerous canals; there are fevers. (8th) At 50 meters. (9th) There is none. (10th) The former more severe. (11th) The river Alhama passes by the village. (12th) The river portion less attacked. (13th) Highways. (14th) Cordons, fumigations, and isolation of the suspected. (15th) Yes. (16th) Collected in the houses and washed in the river. (17th) 39 days—ascend, 17; apogee, 4; descent, 18. (18th) No. (19th) Yes. (20th) 339 attacks—130 males, 209 females. (21st) 86 deaths—33 males, 53 females. (22d) Equally. (23d) There are none.

*San Adrian, 753 inhabitants.*—(1st answer.) From the 21st of August to the 25th of November. (2d) By a person. (3d) First good, second bad. (4th) There is none; night-soil into the court-yards; no public service. (5th) Water from the river Ebro and river Ega, also well water containing filtrations from the Ebro. (6th) No. (7th) Alluvial soil, with pebbles; there is a marsh, but fevers are frequent only in autumn. (8th) At 50 meters from the houses. (9th) There is none. (10th) Three times more castigated in the former, whilst the population was then one-half less. (11th) At the confluence of the rivers Ebro and Ega. (12th) The lower part suffered most, in the proportion of four to one. (13th) By river and by land. (14th) Lazarettos and disinfectants. (15th) Of fruits, no; of vegetables, yes. (16th) In the Ebro and in a stream flowing into it. (17th) 96 days—ascend, 8; apogee, 4; descent, 84. (18th) No; 15 to 20 days. (19th) Yes; almost all. (20th) 47 attacks—26 males, 21 females. (21st) 11 deaths—5 males, 6 females. (22d) 18 to the north, 29 to the south. (24th) It was noticed that those who practiced abuse in the use of grapes suffered from the epidemic.

*Sesma, 1,371 inhabitants.*—(1st answer.) From the 10th of September to the 10th of October. (2d) By a person. (3d) First bad; second good; also damp. (4th) There is none; the night-soil is removed outside the village by the inhabitants. (5th) Used rain-water collected in tanks; it tastes marshy in summer; it is impurifiable. (6th) No. (7th) Tertiary soil; sulphate of lime, or gypsum. (8th) At 300 meters. (10th) In 1834 60 died; in 1855 54 died. (11th) At 7 kilometers from the Ebro, and 8 from the Ega. (13th) A highway. (14th) All. (15th) Prohibited. (16th) In the public lavatories supplied by a fountain. (17th) 31 days—ascend, 15; apogee, 3; descent, 13. (18th) Yes. (19th) Yes; for 37 days before the cholera, mucous diarrhoea. (20th) 100 attacks—45 males, 55 females. (21st) 9 deaths—3 males, 6 females. (22d) Not observed. (23d) There are none. (24th) The grapes did much injury.

*Casada, 1,634 inhabitants.*—(1st answer.) From the 1st of September to the 7th of October. (2d) By persons. (3d) Good. (4th) There is none; filth deposited in the square; no public service. (5th) From the river Aragon. (6th) No. (7th) Calcareous, clay soil; no marshes nor fevers at any time. (8th) At 325 meters. (9th) There is none. (10th) The former greater. (11th)

Upon the river Aragon. (12th) Equally. (13th) Highway and neighboring roads. (14th) All. (15th) Yes. (16th) In the river, and each family in its own house. (17th) 36 days—ascend, 14; apogee, 5; descent, 17. (18th) Yes; the cholera began three days afterwards. (19th) Yes. (20th) 251 attacks—95 males, 156 females. (21st) 51 deaths—children, 7; adults, 33; aged, 11. (22d) All in the lower; equally to the north and south. (23d) There are none.

*Oracain Valle de Olabar, 757 inhabitants.*—(1st answer.) From the 4th to the 8th of September. (2d) Unknown. (3d) All good. (4th) There is none. Filth is used for manure. (5th) Neighboring fountain; good. (6th) No. (7th) Rocky; no marshes nor fevers, but there are pools and pestilences. (8th) At 10 meters the old, and at 50 the new. (9th) There is none. (10th) No former epidemic. (11th) No. (13th) A neighboring road and highways. (14th) Disinfectants. (15th) No. (17th) 5 days. (19th) Yes. (20th) 3 attacks—2 males, 1 female. (21st) 2 deaths—1 male, 1 female. (22d) In the lower and to the south. (23d) There are none.

#### PROVINCE OF GUIPÚZCOA.

*Irún, 7,040 inhabitants.*—(1st answer.) From the 11th of August to the 17th of October. (2d) By persons from infected places. (3d) First, good; second, bad. (4th) There is a system of sewers which empties into the river Bidasoa; cleaning by the municipality. (5th) Spring; good; containing lime and magnesia; besides from small springs, of which a few of the inhabitants make use. (6th) Yes. (7th) Clay in general; some marshes around the opening of the sewers into the Bidasoa; intermittent frequent. (8th) At 1 kilometer to the north. (9th) Iron pipes. (10th) This time less. (11th) On the left bank of the river Bidasoa, where several streams which traverse the town flow into it. (12th) The part near the river was the only portion attacked. (13th) Railroads and highways, particularly that leading to Belcovia, a point which was previously infected. (14th) Disinfectants, medical inspection, and every hygienic measure. (15th) No; sale of fruits proceeding from infected places prohibited. (16th) In public lavatories and in the streams; the clothing is washed outside the houses. (17th) 68 days—ascend, 29; apogee, 7; descent, 32. (18th) The maximum of the epidemic coincided with heavy rains. (19th) Yes. (20th) 199 attacks—94 males, 105 females. (21st) 101 deaths—43 males, 58 females. (22d) In the ground floor, 35; in the first, 118; in the second, 33; in the third, 13. To the north, 73; to the south, 126. (23d) No case in the prisons. (24th) Due to the scrupulous hygiene and to the carefulness in handling the effects of cholera patients.

*Andoain, 2,418 inhabitants.*—(1st answer.) From the 12th to the 25th of October. (2d) It is suspected by a person from an infected place who died. There was no connection between the water in which the clothes are washed and the conduits for the drinking water. (3d) Both bad. (4th) Everything wanting; everything goes to the court-yards, destined for manure. (5th) Spring; good; agreeable. (6th) Yes. (7th) Clay; no marshes nor intermittents. (8th) At 250 meters, completely separated from the village. (9th) Of brick, in bad condition. (10th) This time less. (11th) At the confluence of the two rivers, the Lesaran and the Arumea. (12th) The part next the Arumea suffered the most. (13th) Railway and highway. (14th) Fumigations of baggage and merchandise; no cordons. (15th) Consumption of fruits of the country. (16th) In the river and in the houses. (17th) 13 days—ascend, 4; apogee, 4; descent, 5. (18th) First attack coincided with rains. (19th) Yes. (20th) 49 attacks—26 males, 23 females. (21st) 28 deaths—10 males, 18 females. (22d) The upper stories were those inhabited.

NOTE.—In different houses in the neighborhood of San Sebastián there were 20 cases, which observed the following course:

First case on the 3d of July, proceeding from Madrid. The second case on the 7th of July—a Sister of Charity, infected by the former. Third case on the 15th of July, proceeding from Zaragoza. The fourth case, proceeding from Todolo, on the 6th of August, died. The fifth case, on the 9th of August; two cases, father and son, who died. The sixth case, the wife of the first, following various cases at different intervals up to the 15th of October.

Besides the houses in the neighborhood of San Sebastián, cholera also appeared in Hernani, occasioning only two victims, thanks to the hygienic measures, to the good drinking water,



and sufficient declivity of the site of the town for the prevention of the collection of water in pools.

In Fuenterrabia four cases also occurred, from the 26th of August to the 23d of September, which terminated fatally without giving rise to further propagation. What is this circumstance due to? It is unknown.

#### PROVINCE OF JAEN.

*Real de Becerro*, 2,384 inhabitants.—(1st answer.) From the 8th of July to the 7th of August. (2d) By persons. (3d) First good; second bad. (4th) There is none; inhabitants remove the filth for manure; no public service. (5th) Good spring water collected in a receptacle. (6th) It is suspected, yes, by having used water from the Guadalquivir. (7th) Clay; no marshes, but fevers in autumn in the houses in the country. (8th) At 1 kilometer. (9th) Of iron for a short course. (10th) 1 case in 1834; in 1855, 3; this attributed to want of communication. (11th) There is no river. (13th) Disinfectants. (15th) Yes. (16th) In the public lavatory beyond the village. (17th) 30 days—ascend, 10; apogee, 3; descent, 17. (18th) No. (19th) Yes. (20th) 94 attacks—54 males, 40 females. (21st) 51 deaths—5 children, 34 adults, 12 aged. (22d) All in the lower; equally as respects winds. (23d) There are none. (24th) The great disproportion between the well-to-do and the poor. The epidemic is attributed to the water of the river Guadalquivir.

*Jimena*, 1,134 inhabitants.—(1st answer.) From the 13th of July to the 6th of August. (2d) By persons. (3d) Both bad. (4th) There are sewers empty in the lower part of the town. (5th) Very good spring water. (6th) No. (7th) Cretaceous and clay; no marshes nor fevers. (8th) At 500 meters. (9th) Of brick and iron. (10th) More this time. (11th) At 4 kilometers from the river Garciez and 10 kilometers from the Guadalquivir. (11th) In the upper part there were more cases. (13th) By land. (14th) All. (15th) Yes. (16th) In public lavatories and in running water. (17th) 25 days—ascend, 8; apogee, 8; descent, 9. (18th) No. (19th) No. (20th) 18 attacks—5 males, 13 females. (21st) 12 deaths. (22d) All in the lower; equally as respects winds. (23d) There are none. (24th) Hygiene exacted as a preventive.

*Ibros*, 1,000 inhabitants.—(1st answer.) From the 17th of July to the 27th of August. (2d) By a harvester from Cuenca del Guadalquivir, which was infected. (3d) First good; second bad. (4th) Main sewers; cleaning by the inhabitants. (5th) Spring water; very good, containing magnesia. (6th) No. (7th) Granite; no marshes nor fevers. (8th) At 700 meters. (9th) Of brick. (10th) More in the former. (11th) Near two streams; the river is at 2 leagues. (12th) Equally. (13th) By land. (14th) All. (15th) Yes. (16th) In public lavatories; washing given out. (17th) 40 days; irregular march. (18th) No. (19th) No. (20th) 57 attacks—30 males, 27 females. (21st) 27 deaths—13 males, 14 females. (22d) All in the lower; 15 to the north, 12 to the south. (23d) There are none.

*Villaneuva del Arzobispo*, 5,305 inhabitants.—(1st answer.) From the 21st of July to the 22d of August. (2d) Suspected by persons. (3d) Both bad. (4th) Two small covered streams serve as sewers; no public service. (7th) Clay; pools and ponds in the streets; malarial fever frequent. (8th) At 500 meters. (9th) Of iron. (10th) Much more formerly. (11th) Upon two streams. (12th) More cases in the part along the sewers, containing filth. (13th) By land. (14th) All the Government permitted. (15th) Yes. (16th) In streams. (17th) 32 days; irregular march. (18th) Yes. (19th) Yes. (20th) 19 attacks—7 men, 9 women, 3 children. (21st) 9 deaths—3 men, 5 women, 1 child. (22d) The majority in the lower, and equally as respects winds. (23d) There are none.

*Sabiote*, 3,914 inhabitants.—(1st answer.) From the 25th of July to the 20th of September. (2d) By persons. (3d) First, good; second, bad. (4th) There is none; the night-soil is carried 500 meters distant by the municipality. (5th) Good spring water, containing carbonates of lime. (6th) The first cases were in houses where there were wells with bad water. The use of this water was prohibited. (7th) Good, sandy; no marshes; fevers in autumn. (8th) At 400 meters. (10th) That of 1855 less. (11th) Streams and river at 3 kilometers. (12th) Majority in the houses to the west. (13th) Neighboring road. (14th) All. (15th) Prohibited. (16th)

In the gutters, which are the public lavatories. (17th) 57 days; 19 days each period. (18th) Yes. (19th) Yes. (20th) 208 attacks—83 males, 125 females. (21st) 89 deaths—7 children, 29 adults, 53 aged. (22d) 119 in the upper and 89 in the lower; equally as respects winds. (23d) There are none. (24th) There was a focus of infection near a pool of stagnant water.

*Jaen*, 24,392 *inhabitants*.—(1st answer.) From the 1st of September to the 24th of October. (2d) By a person from Grenada, infecting three children; the person importing the disease recovered. (3d) Both bad. (4th) A short system of sewerage in bad condition, the sewage being conducted to pools outside of the walls for the purpose of manure; the poor inhabitants possess sinks in their houses and also use the court-yards for the deposit of excrement and house-filth, with that of the beasts, for manure; public cleaning by the municipality, but badly performed. (5th) Spring water; very good. (6th) It is suspected that there was communication between the water-pipe and a sewer. (7th) Calcareous soil, tertiary formation; on the side of a mountain called Cerro del Castillo; intermittents are not frequent. (8th) At 1 kilometer from the town. (9th) Lead pipes; in some places across the sewers. (10th) This time much more. (11th) On the bank of the river Jaen. (12th) The lower and dirtier part suffered most. (13th) Railroad and highways. (14th) Disinfectants and cleaning of the houses of the attacked; nothing before. (15th) In public lavatories; the clothing was previously disinfected with a solution of bichloride of mercury, after the contagious property of the clothing had first shown itself by obtaining various victims. (16th) Yes. (17th) 54 days ascent, 12; apogee, 8; descent, 34. (18th) Yes. (19th) Did not coincide with a storm, but with great heat. (20th) 1,262 attacks. (21st) 579 deaths. (23d) In a monastery more than half died. (24th) The majority of deaths occurred in women sick with chronic diseases, particularly intestinal troubles.

*Ubeda*, 8,149 *inhabitants*.—(1st answer.) From the 7th of July to the 14th of October. (2d) By a harvester from a barrier along the river, to which the disease was imported from Sontotome by another harvester. (3d) Both bad. (4th) Short, and in a bad condition; from a want of water the filth collects in pools; the majority of houses contain sinks. (5th) Scarce; spring water; the fountains arise by filtrations; well-water for domestic purposes. (16th) It is suspected that filtrations from the sinks contaminated the drinking water. (7th) Situated upon a sand-bank quite elevated; no marshes; only agricultural laborers suffer intermittent fevers in autumn. (8th) About 2 kilometers distant from the village. (9th) Subterranean aqueducts of earth and brick pipes. (10th) This time less than in 1855, when there died 1,200 in a population of 14,000. (11th) At the confluence of the Guadalquivir and the Guadalimar. (12th) The part along the river suffered most. (13th) Land and rail. (14th) Medical inspection, fumigations; both incomplete. (15th) Generally in the houses, but there are some public lavatories; the latter were closely watched during the epidemic. (16th) Yes. (17th) 98 days—ascent, 39; apogee, 5; descent, 54. (18th) Yes. (19th) Not with the storm, but with great heat and clouds. (20th) 341 attacks. (21st) 197 deaths. (23d) Not attacked in the prison, notwithstanding the crowding. (24th) The majority of the victims were old men and women.

#### PROVINCE OF GRANADA.

*Granada*, 72,417 *inhabitants*.—(1st answer.) From the 13th of July to the 27th of September. (2d) Imported by harvesters from Murcia. (3d) Both very bad. (4th) Only half of the town is sewered; imperfectly. The sewers discharge their water partly into the Genil and partly for irrigation of the surrounding fields. The rest of the city has not even this poor system of sewerage; it uses fixed sinks in the houses; night-soil is thrown into the court-yards and into the streets. (5th) From the rivers Darro and the Genil; containing lime; good. (6th) Justifiably suspected. (7th) Calcareous and damp; abundant vegetation. (9th) The conduits are defective, open tubes, and in some places the water mingles with that of the sewers. (12th) The part containing no sewers suffered the most, likewise the inhabitants outside of the town on the land which was irrigated by sewage water. (13th) By land and rail. (14th) Cordons and lazarettos for travelers and merchandise from infected places, as also from places not infected; observation from four to five days; great abandonment during the period of ascent. (Chemical



and microscopical analysis of the waters was practiced, as also domiciliary visits, inspection of the prisons, asylums, and other public establishments; observation of the merchants. During the epidemic the houses and clothing of the attacked were disinfected; the clothing was washed outside of the town, and for the destruction of the living germs there were fires in the streets.) (15th) Yes. (16th) In the canals. (17th) 76 days—ascend, 27; apogee, 9; descent, 40. (18th) Yes; with a storm. (19th) Yes. (20th) 7,014 attacks. (21st) 3,254 deaths. (24th) The villages located up-stream, using the same river water, were not attacked by the cholera; those which were were invaded subsequently to the capital.

*La Zúbia*, 3,037 inhabitants.—(1st answer.) From the 29th of July to the 15th of September. (2d) By persons from infected places. (4th) There is none; the filth goes to the court-yards. (5th) Very abundant; potable water; used for irrigation from the river Monacid. (6th) No. (7th) Clay; porous soil, ordinary dampness; abundant vegetation. (9th) Of brick; hermetically closed in anticipation of the danger. (12th) The part nearest the streams suffered the most. (14th) Fumigation of houses and burning of ropes. (16th) In the streams which traverse the village. (18th) Yes; with a storm. (19th) Yes. (20th) 447 attacks—286 males, 161 females. (21st) 283 deaths—164 males, 119 females.

*Padul*, 3,651 inhabitants.—(1st answer.) From the 16th of July to the 24th of September. (2d) By a youth of 19 years from an infected place. (3d) Both bad. (4th) There is none; the houses have no sewerage. (5th) Spring water, within and without the village. There is also an open canal conducting water from the Sierra Nevada; during the epidemic the spring water was used. (6th) Yes; for among those who drank the water from the canal in which the clothing of cholera patients was washed there was great suffering. (7th) It is located upon a hill; a spur of the Sierra Nevada, and washed by large streams of water. During the epidemic there were intermittent fevers. (8th) At the side of the village. (9th) There is none. (12th) The sections which suffered most were of the poorer classes; the portion adjoining the cemetery had scarcely any cases. (13th) By land. (16th) During the epidemic, in the canals. (17th) 70 days—ascend, 29; apogee, 7; descent, 34. (18th) Yes. (21st) 263 deaths—117 males, 146 females.

*Gor*, 3,027 inhabitants.—(1st answer.) From the 29th of July to the 3d of September. (2d) Imported by laborers from an infected place. (4th) There is none; everything into the dirty streets. (5th) Spring water. (12th) The poor quarters suffered most. (13th) By land. (14th) Disinfection of the houses where the attacks occurred. (17th) 37 days. (20th) 372 attacks. (21st) 122 deaths.

*Cástaras*, 1,633 inhabitants.—(1st answer.) From the 3d of August to the 27th of September. (2d) Imported by a person from Granada. (3d) Little hygiene. (4th) There is none. (5th) Excellent spring water. (7th) Broken surface; soil consists of volcanic rocks; tertiary clay. (13th) By land. (14th) Lazarettos and quarantines. (17th) 55 days. (18th) After a rain the cholera revived. (20th) 22 attacks. (21st) 12 deaths. (24th) All of the epidemics have been benign.

*Gábia la Grande*, 2,768 inhabitants.—(1st answer.) From the 28th of July to the 18th of September. (2d) By an individual from Granada where the epidemic existed. (3d) Good. (4th) There is none. (5th) Open canals, which conduct the water from the Sierra Nevada, originating from the melting of snow. (7th) Good conditions. (10th) Have always been attacked. (12th) The poor quarters and the most damp, suffered the most. (13th) By land. (14th) On account of prohibition by the government there were no cordons and lazarettos; nothing else. (16th) Clothing washed in the river Genil, which passes by Granada, which was infected. (17th) 52 days. (20th) 303 attacks. (21st) 193 deaths.

*Salobreña*, 3,951 inhabitants.—(1st answer.) From the 22d of July to the 21st of September. (2d) Supposed to be imported from Motril. (3d) Both very bad. (4th) There is none; filth within the special deposits and within the court-yards in the town. (5th) Considered good; containing lime and magnesia. (6th) Ten. (7th) Upon a calcareous rock with clay soil; intermittent fevers frequent. (8th) Within the village; prohibited use of it during the epidemic. (9th) There is none. (10th) This time more than former. (11th) At half a kilometer there is a dry stream, and at 2 kilometers the river Guadalfeo. (12th) Double the

part near the river. (13th) By land. (14th) Disinfectants. (15th) Yes. (16th) Outside of the houses, in the streams and fountains. (17th) 62 days—ascend, 24; apogee, 7; descent, 31. (18th) The increase of the epidemic coincided with a storm. (19th) Yes. (20th) 263 attacks—116 males, 147 females. (21st) 106 deaths—47 males, 59 females. (22d) All are lower stories. (23d) No case in the garrisons. (24th) The greatest number of victims among persons in bad hygienic condition.

*Benamaurel*, 3,421 *inhabitants*.—(1st answer.) From the 8th of July to the 29th of August. (2d) Imported by persons. (3d) Both bad. (4th) There is none; the municipality cleans. (5th) River water; containing magnesia. (6th) No. (7th) Upon a calcareous rock, with clay soil; intermittent fevers frequent. (8th) At 1,000 meters. (9th) There is none. (10th) This time more than in 1855. (11th) Situated upon a river. (12th) Equally. (13th) By land. (14th) Cordons and disinfectants. (15th) Abuse of vegetables, cantaloupes, and watermelons. (16th) Outside of the houses in the rivers. (17th) 53 days—ascend, 18; apogee, 8; descent, 27. (18th) No. (19th) Yes. (20th) 148 attacks—73 males, 75 females. (21st) 85 deaths—46 males, 39 females. (22d) General. (23d) There are none.

*Lachar*, 738 *inhabitants*.—(1st answer.) From the 9th of July to the 23d of August. (2d) Imported. (3d) Very bad. (4th) There is none; the houses are deposits of filth. (5th) Unpleasant; proceeding from the Genil; muddy. (6th) The clothing of the cholera patients was washed in the river. (7th) Frequent intermittents; sandy. (8th) At 82 meters. (9th) Of brick. (10th) This time more. (11th) At 150 meters from the river Gemil. (12th) Equally. (13th) By land. (14th) Cordons lasting nine days. (15th) Abuse of fruits. (16th) In the river. (17th) 45 days—ascend, 11; apogee, 4; descent, 30. (18th) Intense heat. (19th) Yes. (20th) 90 attacks—47 males, 43 females. (21st) 46 deaths—25 males, 21 females. (22d) Generally in the lower. (23d) In the post of the civil guard, 2 attacks and 1 death. (24th) The official physician died.

*Loja*, 18,249 *inhabitants*.—(1st answer.) From the 19th of July to the 19th of September. (2d) Imported by persons. (3d) Good. (4th) Drains in charge of the municipality. (5th) Good fountain water. (6th) The choleraic focus was due to the discharge of the sewage from the houses in which there were cholera patients. (7th) Upon granite and clay; occasionally limestone; no intermittent fevers. (8th) At  $2\frac{1}{2}$  kilometers to the east, in good condition. (9th) Of brick. (10th) This time less than others on account of better hygiene. (11th) Upon both banks of the river Genil. (12th) Part next to the river, little more attacked. (13th) By land. (14th) Lazarettos and disinfectants. (15th) Prohibited during the epidemic. (16th) In public lavatories. (17th) 63 days—ascend, 28; apogee, 6; descent, 29. (18th) No. (19th) No. (20th) 125 attacks—45 males, 80 females. (21st) 81 deaths—28 males, 53 females. (22d) Generally in the lower. (23d) One attack in the prison. (24th) Upon rocks; good water, and hygienic measures.

*Illora*, 8,080 *inhabitants*.—(1st answer.) From the 22d of July to the 11th of September. (2d) Imported by persons. (3d) Good. (4th) There is none; the excrement into the court-yards and into special receptacles within the village. (5th) Good. (6th) No. (7th) Upon granite and clay; no intermittent fevers. (8th) At 1 kilometer. (9th) There is none. (10th) This time less than in 1834. (11th) In part upon the stream Baganchas, which is usually without a current. (12th) Unknown. (13th) By land. (14th) Lazarettos and disinfectants. (15th) Prohibited during the epidemic. (16th) Public lavatories. (17th) 50 days—ascend, 21; apogee, 5; descent, 23. (18th) No. (19th) Yes. (20th) 202 attacks—98 males, 104 females. (21st) 85 deaths—37 males, 48 females. (22d) Equally. (23d) No case in the post of the civil guard. (24th) Greatest number of victims among persons in bad hygienic conditions.

*Chauchina*, 2,463 *inhabitants*.—(1st answer.) From the 22d of July to the 23d of August. (2d) Imported. (3d) Both bad. (4th) There is none; filth in the court-yards and in special receptacles within the town. (5th) Considered good; containing magnesia. (6th) No. (7th) Intermittent fevers frequent; upon a granite, clay soil, surrounded by canals. (8th) At 1,500 meters. (9th) Of brick. (10th) This time less. (11th) Surrounded by canals. (12th) Equally. (13th) By land. (14th) Lazarettos and disinfectants. (15th) Abuse of fruits. (16th) In the house, and during the epidemic in special basins. (17th) 32 days—ascend, 15;



apogee, 3; descent, 14. (18th) Storms and rains 2 or 3 days before the attacks. (19th) Yes. (20th) 137 attacks—60 males, 77 females. (21st) 110 deaths—53 males, 57 females. (22d) Generally in the lower. (23d) There are none. (24th) Choleraic symptoms associated with those of malaria.

*Motril, 16,665 inhabitants.*—(1st answer.) From the 22d of July to the 21st of September. (2d) Imported by persons and donkey loads. (3d) First good, second bad. (4th) There is none; there are sinks which are cleaned at the charge of the municipality. (5th) Wells ordinary, and good water from the river Guadalfeo. (6th) The first attack occurred in persons who used water from the river Guadalfeo, into which various rivers emptied, which passed by villages infected. (7th) Upon granite and clay; some intermittent fevers in summer and autumn. (8th) At 2 kilometers to the northeast. (9th) Up to the town; masonry; within it iron and leaden pipes. (11th) Upon a canal from the river Guadalfeo, which latter is at 1 league from the town. (12th) Equally. (13th) By land. (14th) Observation by river, and disinfectants in the locality. (15th) Abuse of fruits. (16th) The washing given out by the comfortable classes; the poor wash in the canals of the fields. (17th) 62 days—ascend, 30; apogee, 5; descent, 27. (18th) Coincided with storms. (19th) Yes. (20th) 1,454 attacks—881 males, 573 females. (21st) 471 deaths—241 males, 230 females. (22d) Majority in the lower. (23d) No attack in the prison; there is no garrison. (24th) The attacks increased on the days when the irrigation of the fields occurred nearest to the village; only the poor classes suffered.

*Santa Fé, 5,108 inhabitants.*—(1st answer.) From the 23d of July to the 12th of September. (2d) Unknown. (3d) Bad. (4th) The drains at the charge of the municipality. (5th) Wells good at normal times. (6th) The wells may have been contaminated. (7th) Upon layers of clay and sand; intermittent fevers frequent in autumn. (8th) The old at 100 meters; the new used during the epidemic at 1,000 meters. (10th) This time more. (11th) Near the Genil and a stream which is an affluent of it. (12th) Equally. (13th) By land. (14th) Cordons and disinfectants. (15th) Abuse of fruits. (16th) In houses and canals. (17th) 51 days—ascend, 18; apogee, 4; descent, 29. (18th) Heat; rain at the end of the epidemic. (19th) Yes. (20th) 929 attacks—398 males, 531 females. (21st) 492 deaths—209 males, 283 females. (22d) Majority in the lower. (23d) 1 attack in the post of the civil guard.

*Jun, 437 inhabitants.*—(1st answer.) From the 20th of July to the 12th of September. (2d) Imported by river water. (3d) Those of the rich good; those of the poor bad. (4th) There is no one to empty the sinks and the court-yards. (5th) River water and spring water belonging to the village Alfacar; containing lime and magnesia. (6th) It is supposed that the first case used water from the river Juncare. (7th) No fevers. (8th) At 500 meters. (9th) Of brick. (10th) This time more. (11th) In the river Juncare. (13th) By land. (15th) Abuse of fruits. (16th) In the houses, in the canals, and in the river; during the epidemic washing in the canals prohibited. (17th) 54 days—ascend, 27; apogee, 4; descent, 27. (18th) No. (19th) No. (20th) 98 attacks—54 males, 44 females. (21st) 23 deaths—9 males, 14 females. (22d) All in the lower. (23d) There are none.

*Lantera, 1,499 inhabitants.*—(1st answer.) From the 20th of July to the 10th of August. (2d) Imported by persons. (3d) Both very bad. (4th) No one to empty the sinks or court-yards. (5th) Good spring water. (6th) No. (7th) At the foot of the Sierra Nevada; sandy soil; no intermittent fevers. (8th) Within the village at the commencement; afterwards at 1,000 meters. (9th) Of brick. (10th) This time more. (11th) Between two streams. (13th) By land. (14th) Disinfectants. (15th) Abuse of fruits. (16th) In the streams. (17th) 22 days—ascend, 7; apogee, 2; descent, 13. (18th) No. (19th) Yes. (20th) 136 attacks—66 males, 70 females. (21st) 76 deaths—38 males, 38 females. (22d) All in the upper. (23d) There are none. (24th) Equally.

*Lanjarón, 4,181 inhabitants.*—(1st answer.) From the 24th of July to the 4th of October. (2d) Imported by a traveling merchant from Huetortajar, an infected place. (3d) Bad hygienic conditions. (4th) There is none; the municipality cleans; the filth goes into the irrigation canals. (5th) Spring water, good; it has therapeutic properties. (6th) No. (7th) Soil, granite, clay; no marshes nor fevers. (8th) At more than half a kilometer. (9th) Of brick. (10th) This time less. (11th) Situated at the foot of a hill of the Sierra Nevada, near

the river Laujora, and a gully called El Salas. (12th) No difference noted. (13th) By land. (14th) Cordons, lazarettos, and isolation. (15th) Abuse of fruits. (16th) Public lavatories. (17th) 73 days. (19th) Yes. (20th) 31 attacks—17 males, 14 females. (21st) 8 deaths—4 males, 4 females.

*Gastillegar*, 1,921 inhabitants.—(1st answer.) From the 24th of July to the 24th of September. (2d) By communication with neighboring infected village. (3d) Some good, others bad. (4th) There is none; the filth is removed beyond the village. (5th) Good river water. (6th) No. (7th) Clay soil; there are marshes, and frequent intermittent fevers. (8th) At 100 meters distant. (9th) There is none. (10th) This time less than in 1854. (11th) Near the rivers Guardel and Gabra. (12th) The lower part suffered the most, in spite of being inhabited by the better class of the population. (13th) By land. (14th) Cordons and disinfectants. (15th) Abuse of fruits. (16th) In the river. (17th) 62 days—ascend, 20; apogee, 4; descent, 38. (18th) No. (19th) Yes; there was much diarrhœa. (20th) 122 attacks—53 males, 69 females. (21st) 35 deaths—15 males, 20 females. (22d) All are lower stories. (23d) There are none.

*Huescar*, 7,760 inhabitants.—(1st answer.) From the 26th of July to the 26th of August. (2d) Imported by a person from an infected place. (3d) Good and ordinary. (4th) There is none; filth deposited in the court-yards; cleaning at the charge of the inhabitants. (5th) Good spring water, containing lime. (6th) No. (7th) Clay soil; along the banks of the rivers Guardel and Fuecanliente, which flow near the village, fevers in autumn. (8th) The first, adjoining the village; the second, at 300 meters. (9th) Of brick. (10th) This time less. (11th) The eastern part located upon a plain extending toward the river Bravata, and the western part the river Guardal. (12th) Of the cases which occurred, two were within the village, and the other three on the border of the western part. (13th) By land. (14th) Lazarettos and disinfectants. (15th) Inhabitants cautioned against the use of fruits during the epidemic. (16th) Washed in the river. (17th) 32 days. (18th) No. (19th) Yes. (20th) 5 attacks—3 males, 2 females. (21st) 4 deaths—2 males, 2 females. (22d) Equally. (23d) There are none. (24th) Isolation and other measures were the means taken to prevent the development of the epidemic.

*Mochín*, 3,325 inhabitants.—(1st answer.) From the 29th of July to the 29th of September. (2d) Imported by persons. (3d) Generally good. (4th) There is none; the filth is removed by the inhabitants. (5th) Good spring water, containing magnesia. (6th) No. (7th) Granite soil; no marshes nor intermittent fevers. (8th) At 500 meters. (9th) There is none. (10th) Former more. (11th) Upon a river of small importance. (12th) No influence noted. (13th) By land. (14th) Cordons and disinfectants. (15th) No abuse of fruits. (16th) Outside the houses. (17th) 64 days. (18th) No. (19th) Yes. (20th) 15 attacks—7 males, 8 females. (21st) 9 deaths—4 males, 5 females. (22d) All in the lower. (23d) There are none.

*Iznalloz*, 3,036 inhabitants.—(1st answer.) From the 31st of July to the 27th of August. (2d) Imported by a person from Granada. (3d) The locality good, but the houses in bad condition. (4th) There is none; cleaning by the municipality. (5th) Good spring water, containing lime. (6th) No. (7th) Sandy soil; surrounded by the river Cubillas; intermittent fever frequent in summer. (8th) At 500 meters. (9th) Of brick. (10th) The former more. (11th) Upon a river. (12th) Houses near the river suffered most. (13th) By land. (14th) Lazarettos and disinfectants. (15th) Abuse of cantaloupes and salads. (16th) In public lavatories; in the rivers and streams. (17th) 28 days—ascend, 8; apogee, 4; descent, 16. (18th) No. (19th) No. (20th) 29 attacks—10 males, 19 females. (21st) 10 deaths—4 males, 6 females. (22d) All lower. (23d) No attack in the post of the civil guard, nor in the prison. (24th) Precautions were taken to prevent the development of the epidemic.

*Durcal*, 2,626 inhabitants.—(1st answer.) From the 26th of July to the 6th of September. (2d) Imported by persons from infected places. (3d) Both good. (4th) There is none; cleaning of the court-yards by the inhabitants. (5th) Good; fountain and river, containing lime. (6th) No. (7th) Sandy and granite; no marshes nor intermittent fevers; but there is typhoid fever and diarrhœas. (8th) In the center of the village. (9th) Of brick. (10th) In the former more. (11th) No. (12th) No. (13th) By land. (14th) Disinfectants. (15th) Abuse of



fruits and vegetables. (16th) Outside of the houses. (17th) 43 days—ascend, 15; apogee, 4; descent, 21. (18th) No. (19th) No. (20th) 121 attacks—46 males, 75 females. (21st) 53 deaths—28 males, 25 females. (22d) All lower stories, and to the north and south. (23d) There are none.

*Alcudia de Guadix*, 1,541 inhabitants.—(1st answer.) From the 4th of August to the 27th of September. (2d) Imported by persons. (3d) Both very bad. (4th) There are no receptacles; in the court-yards. (5th) Fountains in bad condition, proceeding from springs. (6th) No. (7th) Sandy and clay; intermittent fevers in spring and autumn. (8th) At 1,500 meters; it is in the ward of subterranean dwellings. (9th) There is none. (10th) This time more. (11th) At the confluence of dry streams. (12th) The higher and poorer part suffered most. (13th) By land. (14th) Disinfectants. (15th) Abuse of fruits. (16th) In the canals. (17th) 54 days; ascent and apogee in the month of August. (18th) Attacks and deaths coincided more with north wind than with rain. (19th) Yes. (20th) 157 attacks—53 males, 104 females. (21st) 45 deaths—15 males, 30 females. (22d) Subterranean dwellings. (23d) There are none. (24th) All the pregnant women died in the grave period. Congestive character frequent; opium and lemonade an infusion of canella; quina alcohol gave good results.

*Pino del Valle*, 1,891 inhabitants.—(1st answer.) From the 2d of August to the 16th of September. (2d) Imported by persons. (3d) Bad; northwest winds swept it. (4th) There is none; the fifth is drained into the canals. (5th) Pleasant saline spring water, with lime. (6th) No. (7th) Upon rock; no marshes; intermittent fevers in September and October. (8th) In the center of the town; in bad condition. (9th) There is none. (10th) Did not suffer much this time. (11th) At 2 kilometers from the affluents of the Guadlafoe. (11th) At 200 meters altitude. (12th) Equally. (13th) By land. (14th) No. (15th) Little abuse of fruits and vegetables. (16th) In the stream and near to a basin used for clothing of the cholera patients. (17th) 45 days. (18th) Not observed. (19th) Yes. (20th) 20 attacks—15 males, 5 females. (21st) 6 deaths, males. (22d) All lower; 8 to the west, 3 to the north, and the rest to the south. (23d) There are none. (24th) The disease is generally produced by abuse of fruits. There appeared to be no contagion in the families, except the first attacked; there was no isolation.

*Torbiscón*, 2,590 inhabitants.—(1st answer.) From the 24th of August to the 2d of September. (2d) Imported by persons already attacked. (3d) Ordinary. (4th) There is none; the excrement is removed beyond the village. (5th) Good spring water; hard, from a stream with a gravelly bed. (6th) No. (7th) Sandy; and in the neighborhood deposits of gypsum and sulphate of lime; no marshes nor fevers. (8th) At 200 meters; good condition. (9th) Of brick. (10th) Few cases this time. (11th) Upon a stream almost always dry. (12th) Not observed. (13th) By land. (14th) Cordons and disinfectants. (15th) Abuse of fruits and vegetables. (16th) In the canals from the stream, and in the river Cadir at more than 1 kilometer. (17th) 9 days. (18th) Not observed. (19th) Fifty per cent. of the population in July and August. (20th) 10 attacks—3 males, 7 females. (21st) 2 deaths—1 male, 1 female. (22d) Almost all in the upper. (23d) There are none.

*Alquife*, 841 inhabitants.—(1st answer.) From the 4th of August to the 1st of September. (2d) Imported by persons from infected places. (3d) Both bad. (4th) There is none; deposits in the court-yards; no one charged with public cleaning. (5th) Good spring water. (6th) Yes. (7th) Upon a hill, with a soil somewhat hard and ferruginous; no marshes nor intermittent fevers known. (8th) At the commencement of the epidemic in the center of the population; but later at 600 meters. (9th) Of brick. (10th) This time more than in 1855; unknown why. (11th) It is remote from rivers and streams. (13th) By land. (14th) Disinfectants. (15th) Abuse, particularly of vegetables. (16th) In a running stream. (17th) 28 days—ascend, 8; apogee, 4; descent, 16. (18th) No. (19th) Before and after the epidemic. (20th) 53 attacks—25 males, 28 females. (21st) 14 deaths—7 males, 7 females. (22d) All lower stories. (23d) There are none.

*Otura*, 4,384 inhabitants.—(1st answer.) From the 4th of August to the 8th of September. (2d) Imported by persons. (3d) Good; there is no difference. (4th) There is none; deposits in the court-yards; removed for manure. (5th) Good river water, containing magnesia and a

little lime. (6th) No. (7th) Clay; no marshes; fevers in the autumn. (8th) At 400 meters. (9th) Uncovered aqueduct. (10th) The latter greater. (11th) An irrigation canal passes by the village and supplies it. (12th) Equally. (13th) By land. (14th) Cordons at the commencement of the epidemic, without cutting off communication with the capital. (15th) Abuse of fruits. (16th) In the canals. (17th) 35 days—ascend, 12; apogee, 6; descent, 17. (18th) No. (19th) No. (20th) 122 attacks—50 males, 72 females. (21st) 52 deaths—21 males, 31 females. (22d) Low and damp; deaths in them the same as those exposed to the north. (23d) There are none. (24th) No person well to do died.

*Moreda*, 784 inhabitants.—(1st answer.) From the 4th of August to the 26th of September. (2d) Imported by a person from an infected place. (3d) First good, second bad. (4th) There are none; there are receptacles for excrement in the houses. (5th) Good spring water. (6th) No. (7th) Clay; there are no marshes, and no intermittents within the village. (9th) There is none. (10th) This time more. (11th) Upon a hill; there is no stream nor river. (12th) Equally. (13th) By land. (14th) Cordons at the beginning; these were removed at the commencement of the epidemic, and the death of the mayor who ordered it. (15th) No. (16th) In private basins outside the houses. (17th) 54 days—ascend, 21; apogee, 7; descent, 26. (18th) Yes. (19th) Yes. (20th) 95 attacks—58 males, 37 females. (21st) 39 deaths—19 males, 20 females. (22d) Lower; there are no upper; the attacks were in houses exposed to the south. (23d) There are none.

*Fuente Vuquero*, 1,535 inhabitants.—(1st answer.) From the 6th to the 26th of August. (2d) Unknown. (3d) First, in general, good; second bad. (4th) There is none; cleaning by the municipality. (5th) Good spring water. (6th) No. (7th) Sandy and clay; no marshes; few intermittent fevers. (8th) Within the village; during the epidemic interments were performed at 1,000 meters outside. (9th) There is none. (10th) Equally. (11th) The rivers Genil and Cubellas surround it at 500 meters and 1,000 meters respectively. (13th) By land. (14th) Cordons and disinfectants. (15th) Abuse of fruits. (16th) In public lavatories and in the rivers. (17th) 21. (18th) No. (19th) Yes. (20th) 56 attacks—26 males, 30 females. (21st) 27 deaths—12 males, 15 females. (22d) All lower, and to the north and south. (23d) There are none.

*Chite y Talará*, 921 inhabitants.—(1st answer.) From the 8th to the 21st of August. (2d) Imported from a neighboring infected village. (3d) First good, second bad. (4th) There is none; cleaning by the inhabitants. (5th) Good spring water, conducted by canals 2 kilometers in length. (7th) Granite and clay; few intermittent fevers. (8th) In the center of the village. (9th) Open canal. (10th) Equally. (11th) In a valley, at 3 kilometers from a river. (13th) By land. (14th) Disinfectants. (15th) Abuse of fruits. (16th) In streams and branches of irrigation canals. (17th) 14 days—ascend, 8; descent, 6. (18th) With fogs; the first case. (19th) Some. (20th) 17 attacks—12 males, 5 females. (21st) 9 deaths—7 males, 2 females. (22d) All lower. (23d) There are none.

*Abuñuelas*, 1,903 inhabitants.—(1st answer.) From the 10th of August to the 12th of September. (2d) Imported by persons. (3d) Bad, for the houses are made of wood, and are ruined by earthquakes. (4th) There is none; destroyed by the earthquake. (5th) Good spring water. (6th) No. (7th) Sandy and clay; fevers not frequent. (8th) In the midst of the village. (9th) By an open canal. (10th) This time less than in 1875. (11th) At 1 kilometer from the river. (12th) Equally. (13th) By land. (14th) Isolation, cordons, lazarettos, and disinfectants. (15th) Abuse of vegetables. (16th) In the river outside of the village. (17th) 33 days—ascend, 15; apogee, 7; descent, 11. (18th) After a storm the descent began. (19th) Yes. (20th) 51 attacks—30 males, 21 females. (21st) 32 deaths—18 males, 14 females. (22d) All lower; the majority to the south. (23) There are none.

*Montefrío*, 10,263 inhabitants.—(1st answer.) From the 11th of August to the 11th of September. (2d) Imported by persons. (3d) Good. (4th) There are some underground sewers; the night-soil is removed to the fields; cleaning by the municipality. (5th) Good spring water; containing lime. (6th) No. (7th) Calcareous and clay; no marshes nor intermittent fevers. (8th) In the center. (9th) Of brick. (10th) This time less. (11th) In the midst of various small streams. (13th) By land. (14th) Cordons and lazarettos and disinfectants. (15th)



Abuse of fruits. (16th) In streams and outside of the village. (17th) 31 days. (18th) No. (19th) Yes. (20th) 22 attacks—11 males, 11 females. (21st) 6 deaths—1 male, 5 females. (22d) Lower; to the south, 3. (23d) There are none.

*Alfacar*, 1,627 inhabitants.—(1st answer.) From the 12th of August to the 18th of September. (2d) Imported by infected persons. (3d) Both good. (4th) There is none; the water from the public lavatories runs in open gutters. The night-soil is deposited in the court-yards; cleaning by the municipality. (5th) Good spring water. (6th) No. (7th) Sandy; no marshes nor fevers. (8th) At 1,500 meters. (9th) Of brick. (10th) This time less. (11th) On the side of a mountain and between two streams which collect and receive the water from this locality and from the village of Nevar. (12th) In the lower part near the river increased mortality was observed. (13th) By land. (14th) Lazarettos and disinfectants. (15th) Abuse of fruits and vegetables; in the public lavatories. (17th) 37 days—ascend, 12; apogee, 4; descent, 21. (18th) The ascent coincided with elevation of temperature, and the descent with rain. (19th) Yes. (20th) 51 attacks—18 males, 33 females. (21st) 27 deaths—10 males, 17 females. (22d) 38 in the lower; 13 in the upper; 20 houses to the north and 31 to the south. (23d) There are none. (24th) There was much suffering and absence of hygiene.

*Huêneja*, 2,393 inhabitants.—(1st answer.) From the 7th of August to the 2d of September. (2d) Imported by a person from an infected place. (3d) In general good. (4th) There is none; the houses and court-yards are receptacles for excrement; streets and squares rarely cleaned by the inhabitants. (5th) Good; mountain spring. (6th) No. (7th) Sandy; no marshes, but intermittent fevers. (8th) At 1 kilometer. (9th) The village is supplied by canals which conduct the water for irrigation. (10th) This time more. (11th) Upon a river. (12th) In the proportion of 3 to 1. (13th) By land. (15th) Abuse of vegetables. (16th) In the river. (17th) 27 days. (18th) No. (19th) Yes. (20th) 36 attacks—24 males, 12 females. (21st) 25 deaths—13 males, 12 females. (22d) All lower stories. (23d) There are none.

*Quentar*, 4,408 inhabitants.—(1st answer.) From the 14th to the 28th of August. (2d) Imported by persons. (3d) Good, and the houses of the attacked very damp. (4th) There is none. (5th) Good; spring water, containing a large quantity of magnesia. (6th) Unknown. (7th) Sandy and clay; no marshes, but frequent fevers in autumn. (8th) In the village. (9th) There is none. (10th) Equally. (11th) Upon the river Aguas Blancas. (12th) Equally. (13th) By land. (14th) Lazarettos and disinfectants. (15th) Abuse of fruits and vegetables. (16th) In the river, and some in the houses. (17th) 14 days—ascend, 7; apogee, 2; descent, 5. (18th) No. (19th) Yes. (20th) 15 attacks—7 males, 8 females. (21st) 7 deaths—4 males, 3 females. (22d) All lower and to the south. (23d) There are none.

*Cullar-Bazza*, 7,417 inhabitants.—(1st answer.) From the 18th of August to the 26th of September. (2d) Imported by persons from infected places. (3d) First good; second bad. (4th) There is none; sinks, which the inhabitants clean for manuring the soil. (5th) Medium; spring water, collected in fountains; pleasant and hard, and with a large quantity of lime salts. (6th) No. (7th) Sandy; no marshes nor fevers. (8th) At 1 kilometer, and in good condition. (9th) There is none. (10th) Very little, and not at all in the former. (11th) At 100 meters from a small stream, which is lost in the surrounding plain. (12th) The upper part, and distant from the river, suffered most. It was in bad hygienic condition, because the dwellings are subterranean. (13th) By land. (14th) Cordons and quarantines before the invasion; disinfectants afterwards. (15th) Abuse of fruits and vegetables. (16th) In the streams; during the cholera the clothing of the cholera patients was washed, after disinfection and boiling, in a special locality. (17th) 40 days. (18th) No. (19th) Yes. (20th) 337 attacks—109 males, 228 females. (21st) 43 deaths—16 males, 27 females. (22d) Generally to the lower and to the south. (23d) There was one attack in the post of the civil guard. (24th) The epidemic attacked principally the women and the poor.

*Piñar*, 850 inhabitants.—(1st answer.) From the 18th to the 30th of August. (2d) Imported by persons from infected places. (3d) Both bad. (4th) There is none; cleaning by the municipality. (5th) Good, hard spring water. (6th) No. (7th) Calcareous; no marshes nor fevers. (8th) At 1,000 meters. (9th) Of brick. (10th) There was no former epidemic. (11th) Situated near a stream. (12th) Equally. (13th) By land. (14th) Cordons and fumigations. (15th)

The entrance of fruits prohibited. (16th) In the river. (17th) 13 days. (18th) No. (20th) 9 attacks—4 males, 5 females. (21st) 3 deaths—2 males, 1 female. (22d) Lower stories; to the south and north. (23d) There are none. (24th) Medical observation proved that isolation was the best preventive measure.

*Murchas, 362 inhabitants.*—(1st answer.) From the 19th to the 29th of August. (2d) Unknown. (3d) General condition good, but there are many badly constructed wooden houses in the village. (4th) There is none; public service wanting. (5th) Soft spring water, containing magnesia. (6th) No. (7th) Clay; no marshes nor fevers. (8th) Near the village. (9th) There is none. (10th) In 1855 there were a few cases. (11th) Upon a river; it is dry in summer. (12th) No difference. (13th) By land. (14th) Nothing except disinfectants. (15th) Abuse of fruits and vegetables. (16th) At springs. (17th) 11 days. (19th) Yes. (20th) 4 attacks—3 males, 1 female. (21st) 4 deaths—3 males, 1 female.

*Algarrinejo, 5,609 inhabitants.*—(1st answer.) From the 21st of August; lasted only one day. (2d) Imported by persons already attacked. (3d) Good. (4th) There is none; closed wells; (that is sinks) cleaning by the municipality. (5th) Good spring water. (6th) No. (7th) Clay; no marshes intermittent fevers very rare. (8th) Adjoining the village. (10th) This time less. (11th) At the confluence of two streams. (12th) Equally. (13th) By land. (14th) Disinfectants. (15th) No abuse of fruits. (16th) In the streams; outside of the village. (17th) 1 day. (20th) 1 attack—female. (21st) 1 death—female. (22d) Lower stories point to the north.

*Dúdar, 268 inhabitants.*—(1st answer.) From the 24th of August to the 7th of September. (2d) By persons from infected places. (3d) The hygienic conditions of the locality good; the houses of the first attacked in bad condition in the interior. (4th) There is none; each inhabitant carries the filth of his own house to the fields for manure; public cleaning by the inhabitants. (5th) Good spring water, containing magnesia. (6th) No. (7th) Clay; no marshes nor intermittent fevers. (8th) Adjoining the village. (9th) There are none; the drinking water which is used originates in the village. (10th) Equally. (11th) Upon the river Aguas Blancas. (12th) Equally. (13th) By land. (14th) Disinfectants. (15th) Abuse of fruits and vegetables. (16th) In streams proceeding from the springs. (17th) 15 days—ascend, 5; apogee, 3; descent, 7. (18th) Not observed. (19th) Yes. (20th) 23 attacks—10 males, 13 females. (21st) 6 deaths—3 males, 3 females. (22d) There were 16 attacks in the lower; in the upper, 7; to the north, 14; to the south, 9. (23d) There are none.

*Lújar, 1,193 inhabitants.*—(1st answer.) There was one case in the first days of September. (2d) By a person already attacked. (3d) Good in general. (4th) There is none; the inhabitants do the public cleaning. (5th) Good spring water, composition unknown. (6th) No. (7th) Granite, calcareous; no marshes nor intermittent fevers. (8th) 500 meters. (9th) There is none. (10th) In former epidemic there were not more than three cases; this fact attributed to cordons. (11th) There are no rivers or streams. (13th) By land. (14th) Cordons, lazarettos, and disinfectants. (15th) Abuse of fruits and vegetables. (16th) Public lavatories. (17th) There is only one case. (20th) 1 attack—male. (21st) No deaths. (22d) A single attack to the north, and in the upper stories. (23d) There are none. (24th) The inhabitants of the district live in bad hygienic conditions.

*Fórnes, 746 inhabitants.*—(1st answer.) From the 9th of September to the 9th of October. (2d) By a person. (3d) First ordinary; second bad. (4th) There is none. (5th) Springs. (6th) No. (7th) Clay; no marshes. (8th) In the center of the village. (9th) There is none. (10th) This time more. (11th) Near the confluence of two river. (12th) Equally. (13th) By land. (14th) Cordons, lazarettos, and disinfectants. (15th) Abuse of fruits. (16th) In the river. (17th) 30 days. (18th) Did not spread, cases were imported. (19th) No. (20th) 3 attacks—males. (21st) 2 deaths—males. (23d) There are none.

*Picena, 887 inhabitants.*—(1st answer.) From the 10th to the 23d of September. (2d) Unknown. (3d) Both bad. (4th) There is none; cleaning by the municipality. (5th) Good river and spring water, hard, containing magnesia. (6th) No. (7th) Granite and clay; no springs, and few intermittent fevers. (8th) Adjoining the village. (9th) There is none. (10th) This time less. (11th) Upon streams. (12th) Suffered most near the river. (13th) By land.



(14th) Cordons and disinfectants. (15th) Abuse of fruits and vegetables. (16th) In boiled water and in the river. (17th) 13 days. (18th) Unknown. (19th) No. (20th) 13 attacks—males. (21st) 13 deaths—males. (22d) All to the south. (23d) There are none.

#### PROVINCE OF SANTANDER.

*Reocín, 3,225 inhabitants.*—(1st answer.) From the 18th of August to the 2d of October. (2d) Unknown. (3d) First, good; second, bad. (4th) There is none; cleaning by the inhabitants. (5th) Spring and river water. (6th) No. (7th) Sandy, calcareous, and clay; no marshes; few fevers. (8th) At 450 meters. (9th) There is none. (10th) This time more. (11th) Upon the river Saja. (12th) Equally. (13th) Neighboring roads. (14th) Disinfectants and isolation. (15th) Yes. (16th) In the streams and river and wells. (17th) 45 days—ascend, 29; apogee, 6; descent, 10. (18th) Yes. (19th) Yes. (20th) 61 attacks—22 males, 39 females. (21st) 17 deaths—11 males, 6 females. (22d) All in the lower. (23d) There are none.

*Santa María de Cayón, 2,544 inhabitants.*—(1st answer.) From the 1st to the 22d of September. (2d) Unknown. (3d) First, ordinary; two very bad. (4th) There is none; wanting. (5th) Fountain and well water besides river water. (6th) No. (7th) Calcareous; there are marshes and fevers. (8th) At 200 meters. (9th) There is none. (10th) In 1855, less. (11th) The infected places near a small river, of slow current. (12th) All the attacked near the river. (13th) Highways. (14th) Disinfectants. (15th) Vegetables principal food. (16th) In river and in houses. (17th) 21 days. (18th) There were before the epidemic. (19th) Yes; during and afterwards. (20th) 14 attacks—5 males, 9 females. (21st) 7 deaths—4 males, 3 females. (22d) All the upper stories and to the south, except one lower and to the north. (24th) The attacked lived upon the banks of a dry stream, which flows when there is sufficient run of water.

#### PROVINCE OF VIZCAYA.

*Bilbao, 32,734 inhabitants.*—(1st answer.) From the 4th of August, and it had not ended on the 9th of December, the date when the statistics were obtained. (2d) Unknown. (3d) First good; second bad. (4th) Flag-stone, with a cap of the same material; the sewers empty into the river; cleaning by the municipality. (5th) Very good and abundant springs. (6th) Unknown. (7th) Clay and marl; no marshes nor fevers. (8th) Both distant; one was closed during the epidemic. (9th) Iron pipes. (10th) All the former were insignificant. (11th) Upon the river Nervion where it empties into the sea. (12th) Few cases were scattered. (13th) Of all kinds. (14th) Of all kinds and the best. (15th) No. (16th) In public lavatories and rivers. (17th) It continued from the 4th of August; with a regular march. (18th) Unknown. (19th) Yes; as in former years. (20th) 20 attacks—8 males, 12 females. (21st) 9 deaths—3 males, 6 females. (22d) In the lower, 6; in the upper, 14; to the north, 9; to the south, 6; to the east, 2; and to the west, 3. (24th) Good regimen proved efficacious.

*Orozco, 3,002 inhabitants.*—(1st answer.) From the 21st of September to the 6th of November. (2d) Unknown. (3d) First good; second bad. (4th) There is none; the night-soil is collected for manure; the surface filth goes into the river. (5th) Good spring water. (6th) Well-water is suspected in which dejections of cholera patients were thrown. (7th) Granite and limestone; no marshes nor fevers. (8th) At 1 kilometer. (9th) There is none. (10th) Less. (11th) At the confluence of two small rivers. (12th) The part remote from the rivers most attacked. (13th) Neighboring roads. (14th) Isolation and disinfectants. (15th) No. (16th) In streams and rivers. (17th) 45 days—ascend, 10; apogee, 6; descent, 29. (18th) No. (19th) Yes. (20th) 17 attacks—9 males, 8 females. (21st) 6 deaths—3 males, 3 females. (22d) All in the lower; all to the south, except 1 to the north. (23d) There are none.

*Abanto y Ciérbana, 2,260 inhabitants.*—(1st answer.) From the 12th of October [the termination not given]. (2d) By persons from infected places. (3d) The ancient village is in ordinary condition, but in the modern portion bad on account of crowding. (4th) Sewers of masonry work; the filth is removed into stables by contract. (5th) Good spring water; pleasant. (6th) No. (7th) In part calcareous and clay; no marshes nor intermittent fevers. (8th) The nearest at 300 meters. (9th) There is none. (10th) In former epidemics there were

fewer attacks, but the population was only one-tenth what it is now. (11th) Upon hills and at the foot of them two small rivers. (12th) Equally. (13th) Railways and highways. (14th) Isolation and disinfectants. (15th) Yes. (16th) In lavatories and in rivers; various well-to-do families give their clothing out to wash. (17th) 35 days. (18th) Yes; to a slight degree. (19th) Yes. (20th) 61 attacks. (21st) No data. (22d) Not easy to classify in a village so anomalous as this. (23d) There are none.

*Sopuerta*, 1,447 *inhabitants*.—(1st answer.) From the 10th to the 16th of November. (2d) By persons from infected places. (3d) Both bad. (4th) There is none; cleaning by the inhabitants. (5th) Good spring water; most of the springs contain a quantity of lime. (6th) No. (7th) Calcareous and clay; no marshes nor intermittent fevers. (9th) Of brick and iron. (10th) This time much more. (11th) Upon rivers. (12th) Equally. (13th) By land. (14th) Isolation, disinfectants, and sanitary inspection. (15th) Abuse of vegetables. (16th) In rivers and outside houses. (17th) 5 days. (18th) Unknown. (19th) Yes. (20th) 9 attacks—4 males, 5 females. (21st) 2 deaths—males. (22d) Lower stories and to the south.

The epidemic extended to smaller districts—Ortuella, Matamoras, San Pedro Abanto—where there were 265 attacks and 92 deaths from October 4 to November 13.

#### PROVINCE OF CÓRDOBA.

*Fuente Tojar*, 1,482 *inhabitants*.—(1st answer.) From the 28th of August to the 10th of September. (2d) By effects from infected places. (3d) Both bad. (4th) There is none; no public cleaning. (5th) Good spring water, containing lime. (6th) Those attacked used well-water in bad condition. (7th) Sandy; no marshes nor fevers. (8th) At 200 meters. (9th) There is none. (10th) This time more. (11th) Level plain. (13th) By land. (14th) Disinfectant. (15th) Yes. (16th) In fountains; all clothing washed away. (17th) 13 days—ascend, 3; apogee, 4; descent, 6. (18th) Variable weather during the development of the epidemic; clouds during the descent. (19th) Yes. (20th) 77 attacks—37 males, 40 females. (21st) 34 deaths—14 males, 20 females. (22d) Houses one story.

*Iznajar*, 6,058 *inhabitants*.—(1st answer.) From the 18th of July to the 20th of September. (2d) Unknown. (3d) Both good. (4th) There is none; the filth is deposited in special places and afterwards removed to the fields for manure; cleaning by the inhabitants. (5th) Good spring water. (6th) Use of the river. (7th) Upon rocks; no marshes in the immediate neighborhood; few fevers. (8th) In the center of the town. (9th) Of brick. (10th) This time more than in 1855. (11th) The southern part on the river Genil, the northern part on a stream. (12th) Equally. (13th) By land. (15th) Abuse of cucumbers and salads. (16th) The custom of giving clothing out to wash is in vogue; washing in the streams and river. (17th) 74 days—ascend, 23; apogee, 4; descent, 47. (18th) No. (19th) No. (20th) 296 attacks—144 males, 152 females. (21st) 112 deaths—56 males, 56 females. (22d) The majority of the houses have only one story, and are exposed to the north and south. (23d) There are none.

#### PROVINCE OF OVIEDO.

*Rivaddeva*, 2,728 *inhabitants*.—(1st answer.) From the 21st of August to the 16th of October. (2d) Unknown. (3d) First good; second bad. (4th) There is none; the filth is washed away by the rains into the lowest part of the village; cleaning by the inhabitants. (5th) Spring water of good quality. (6th) No. (7th) Sandy and clay; there are marshes and intermittent fevers in autumn. (8th) At 1 kilometer. (9th) There is none. (10th) This time less. (11th) The greater part of the village is elevated above the river Deva. (12th) The parish nearest the river Buestio suffered most. (13th) Neighboring roads and by sea. (14th) Medical inspection; upon the Basti bridge over the river Deva; fumigations of travelers and baggage. (15th) Abuse of fruits and vegetables. (16th) In river and in public lavatories. (17th) 56 days. (18th) The height of the epidemic during the cloudy weather. (19th) Yes. (20th) 26 attacks—7 males, 19 females. (21st) 12 deaths—3 males, 9 females. (22d) In the upper stories. (23d) There are none.



## PROVINCE OF ÁVILA.

*Madrigal de Las Torres*, 2,871 inhabitants.—(1st answer.) From the 24th of July to the 26th of September. (2d) Imported from Segovia. (3d) First good; second ordinary. (4th) There is none; the night-soil deposited in court-yards; cleaning by the municipality. (5th) Good spring water, containing lime. (6th) The first attacked used well-water infected by the comma bacillus. (7th) Clay, sandy; no marshes nor fevers. (8th) At 500 meters. (9th) Several lead pipes in bad condition. (10th) In 1855 it was attacked, but not in 1865, in spite of being surrounded by infected villages; it was then isolated by cordons. (11th) There is no river—only a stream. (13th) By land. (14th) Disinfectants. (15th) Yes. (16th) In public lavatories, basins and pools; only during epidemic were special basins designated for the washing of clothing of cholera patients. (17th) 54 days—ascend, 27; apogee, 9; descent, 18. (18th) Yes, with rains and storms. (19th) Yes. (20th) 349 attacks—138 males, 211 females. (21st) 105 deaths—33 males, 72 females. (22d) All in the lower stories without distinction, to north and south.

## PROVINCE OF SALAMANCA.

*Villarino*, 1,133 inhabitants.—(1st answer.) From the 18th of July to the 1st of September. (2) By persons from infected places. (3d) Both ordinary. (4th) There is none; cleaning by the inhabitants. (5th) Good spring water. (6th) No. (6th) Granite; no marshes; fevers in summer and autumn. (8th) At 500 meters. (9th) There is none. (10th) Less this time. (11th) Two kilometers from the river Duero. (12th) Equally. (13th) The river Tormes, which passes near Salamanca, a locality which is already infected. (14th) Disinfectants. (15th) Frequently, of vegetables and fruits. (16th) In the river and in the streams. (17th) 43 days. (18th) No. (19th) Yes. (20th) 7 attacks—5 males, 2 females. (21st) 5 deaths—3 males, 2 females. (22d) Unknown. (23d) There are none.

*Huerta*, 425 inhabitants.—(1st answer.) From the 22d of July to the 21st of September. (2d) Unknown. (3d) Both ordinary. (4th) There is none; the surface water runs into the river Tormes, which flows around the town; to the west and south of the town, there is a stream which flows the greater part of the year. (12th) Equally. (13th) By land. (14th) Disinfectants. (15th) No. (16th) In the river. (17th) 63 days. (18th) After days of rain the mortality ceased, to revive again in 12 days. (19th) Yes. (20th) 126 attacks. (21st) 21 deaths. (22d) All lower, and the same to the north and south. (23d) There are none. (24th) Women, old men, and infants, and those affected with chronic diseases, suffered most.

*Villamayor*, 461 inhabitants.—(1st answer.) From the 29th of July to the 2d of October. (2d) Unknown. (3d) Both bad. (4th) There is none; the cleaning by the inhabitants. (5th) Spring and fountain water; pleasant, containing a little magnesia. (6th) No. (7th) Clay; the village is located in a hollow; fevers are frequent the whole year, and the town is surrounded by marshes. (8th) At 500 meters. (9th) There is none, the streams pass through the middle of the town. (10th) Former more. (11th) Situated at the confluence of several streams. (12th) The part near the river less affected. (13th) Highways. (14th) Disinfectants. (15th) Abuse of fruits and vegetables. (16th) In pools and in the houses. (17th) 64 days—ascend, 18; apogee, 14; descent, 32. (18th) Yes. (19th) Yes. (20th) 16 attacks—5 males, 11 females. (21st) 12 deaths—5 males, 7 females. (22d) Lower stories and to the north.

*Almenara*, 380 inhabitants.—(1st answer.) From the 11th of August to the 1st of September. (2d) By water of the river Tormes. (3d) First good, second bad. (4th) There is none; the rains clean the streets. (5th) From the river Tormes; good and agreeable. (6th) From the river. (7th) Clay and granite; no marshes nor fevers. (8th) In the village. (9th) Of brick. (10th) Equally. (11th) At 200 meters from the Tormes. (12th) Equally. (13th) By land. (14th) Cleanliness, prohibition of river water, disinfectants, and carbolic acid. (15th) Cantaloupes and watermelons. (16th) In the river; each person. (17th) 20 days. (18th) No. (19th) Yes. (20th) 25 attacks. (21st) 7 deaths. (22d) They inhabit only the lower stories. (24th) The river contained the germ; the epidemic fell in proportion as this water ceased to be used.

*Calzada de Béjar*, 464 inhabitants.—(1st answer.) From the 14th of August to the 7th of September. (2d) Unknown. (3d) Both bad. (4th) There is none; cleaning by the inhabi-

tants. (5th) Spring water. (6th) No. (7th) Clay; there are marshes, but fevers are not frequent. (8th) At 500 meters. (9th) There is none. (10th) More this time. (11th) No prominent river nor streams. (13th) By land. (14th) Disinfectants. (15th) All classes of fruits. (16th) In wells; clothing not usually given out to wash. (17th) 25 days—ascend, 14; apogee, 3; descent, 8. (18th) No. (19th) No. (20th) 70 attacks—28 males, 42 females. (21st) 29 deaths—8 males, 21 females. (22d) Almost all in the lower. (23d) There are none.

*Topas, 1,071 inhabitants.*—(1st answer.) From the 21st of August to the 3d of November. (2d) It is thought by persons from a village, which was in communication with Funte Sanco, an infected place. (3d) Both bad. (4th) There is none; filth into the court-yards and streets; the municipality charged with enforcing the laws relating to public cleanliness. (5th) From fountains and from a small river; the first contains lime and magnesia, and vegetables do not grow well when watered by it; that of the river is softer, but, on the other hand, it contained the germs of the disease. (6th) No. (7th) Granite and clay; there are pools of water and marshes in the immediate neighborhood; fevers are frequent, especially during times of rain, and in autumn. (8th) At 80 meters, and in the part of the town which is in worst hygienic condition. (9th) There is none. (10th) More this time. (11th) Situated upon a small river. (12th) More in the lower part of the town. (13th) By land. (14th) Some special disinfection. (15th) Abuse of fruits; noticed that the epidemic increased with the use of cantaloupes. (16th) In the small river by the interested parties. (17th) 74 days. (18th) The mortality was greater during times of storms and rains. (19th) Yes. (20th) 24 attacks—14 males, 10 females. (21st) 16 deaths—6 males, 10 females. (22d) All in the lower; to the north, 4; to the northwest, 16; to the south, 4. (23d) There are none. (24th) The epidemic began in the form of rapid attacks, and it was noticed that those persons most predisposed to the attacks by gastro-intestinal troubles suffered most.

*Matilla de los Caños, 1,429 inhabitants.*—(1st answer.) From the 22d of August to the 20th of September. (2d) By persons. (3d) The first, fair; the second, miserable. (4th) Everything wanting. (5th) Fountains; by the side of the streams or wells; soft. (6th) No. (7th) Sandy and clay; no marshes; fevers in November. (8th) At 200 meters. (9th) There is none. (10th) Less. (11th) Upon a stream. (12th) One-tenth more. (13th) By land. (14th) Disinfectants. (15th) Peppers and cucumbers. (16th) In the stream; whoever pleases. (17th) 29 days—ascend, 13; apogee, 4; descent, 12. (18th) No. (19th) No. (20th) 51 attacks—19 males, 32 females. (21st) 11 deaths—5 males, 6 females. (22d) All lower. (23d) No attack in the post of the civil guard.

*Horquijuela de la Sierra, 748 inhabitants.*—(1st answer.) From the 8th to the 16th of September. (2d) Unknown. (3d) First good, second bad. (4th) There is none; the filth is removed to the fields or goes into the streams. (5th) Excellent mountain springs. (6th) No. (7th) Rocky; no marshes; fevers in spring and autumn. (8th) At 300 meters. (9th) Of stone, brick, and zinc. (11th) At the confluence of various streams. (12th) Paths. (14th) Disinfectants and isolation. (15th) Vegetables and fruits. (16th) In the stream; each one. (17th) 8 days. (18th) Yes. (19th) No. (20th) 54 attacks—26 males, 28 females. (21st) 23 deaths—13 males, 10 females. (22d) Only the lower stories inhabited.

*Villar de la Reina, 957 inhabitants.*—(1st answer.) From the 11th of August to the 21st of September. (2d) Imported by clothing from Salamanca, an infected place. (3d) Both bad. (4th) There is none; cleaning unknown. (5th) The water from wells; also from marshy land. (13th) By land. (14th) Cordons. (17th) 41 days. (20th) 75 attacks. (21st) 35 deaths.

#### PROVINCE OF ALMERÍA.

*Fines, 1,257 inhabitants.*—(1st answer.) From the 13th of July to the 20th of August. (2d) By persons from infected places. (3d) First good, second bad. (4th) No system of cleaning. (5th) Good, pleasant spring water. (6th) No. (7th) Clay; no marshes nor fevers. (8th) At 500 meters. (9th) There is none. (10th) No former epidemics. (11th) On the left bank of the river Almanzora, at 800 meters distance. (12th) Equally. (13th) By land. (14th) Hygiene. (15th) Abuse of fruits. (16th) In the river and outside of the house. (17th) 38



days—ascend, 10; apogee, 9; descent, 19. (18th) No. (19th) Yes. (20th) 71 attacks—31 males, 40 females. (21st) 25 deaths—8 males, 17 females. (22d) All in the lower; 40 to the north; 31 to the south.

*Senés, 756 inhabitants.*—(1st answer.) From the 13th of July to the 20th of September. (2d) The disease began in an isolated locality outside of the town, without having had communication with the diseased. (3d) Both bad. (4th) There is none; cleaning by the municipality. (5th) Spring water collected in reservoirs and distributed. (6th) No. (7th) Clay; no marshes nor fevers. (8th) At 21 meters. (9th) Of stone. (10th) Less. (11th) At the confluence of three streams. (12th) The part most from the streams attacked. (13th) Highways. (14th) Disinfectants. (15th) Yes. (16th) In the streams. (17th) 69 days—ascend, 3; apogee, 7; descent, 59. (18th) No. (19th) Yes. (20th) 49 attacks—24 males, 25 females. (21st) 18 deaths—7 males, 11 females. (22d) All in the lower. (23d) There are none.

*Olula del Río, 1,854 inhabitants.*—(1st answer.) From the 23d of July to the end of August. (2d) Unknown. (3d) Both miserable. (4th) There is none; cleaning by the municipality. (5th) Good spring water. (6th) No. (7th) Surrounded by a river; fevers in summer and autumn. (8th) At 300 meters. (9th) There is none. (10th) Less. (11th) Upon the river Almauzora and upon streams. (12th) The lower part and that near the river suffered most. (13th) Highways. (14th) All. (15th) Yes. (16th) In the river and in canals. (17th) 39 days—apogee, 20. (18th) No. (19th) No. (20th) 110 attacks. (21st) 29 deaths—10 men, 15 women, 4 children. (22d) All in the lower. (23d) There are none.

*Castro, 310 inhabitants.*—(1st answer.) From the 23d of July to the 4th of August. (2d) By persons from infected places. (3d) Both very bad. (4th) Everything wanting. (5th) From streams; good. (6th) No. (7th) Granite; no fevers. (8th) Adjoining the village. (9th) There is none. (10th) There were no former. (11th) Upon a stream. (12th) Equally. (13th) By land. (14th) Disinfectants. (15th) Vegetable food. (16th) In the stream; in the lowest part of the stream, as the water is used for drinking. (17th) 12 days—ascend, 4; apogee, 3; descent, 5. (18th) No. (19th) No. (20th) 43 attacks—20 males, 23 females. (21st) 16 deaths—9 males, 7 females. (22d) All the houses are one-story.

*Benínar, 1,151 inhabitants.*—(1st answer.) From the 5th to the 27th of August. (2d) On account of heated air coming from the south. (3d) Both bad. (4th) There is none; cleaning by the inhabitants. (5th) Good river water. (6th) No. (7th) Sandy; no marshes nor fevers. (8th) Adjoining the village. (9th) There is none. (10th) That of 1855 greater. (11th) Upon a river. (12th) Equally. (13th) By land. (14th) All. (15th) Yes. (16th) In the river and outside of the house. (17th) 22 days—ascend, 12; apogee, 6; descent, 4. (18th) Coincided with fogs. (19th) Yes. (20th) 129 attacks—67 males, 62 females. (21st) 37 deaths—17 males, 20 females. (22d) All in the lower. (23d) There are none. (24th) It is believed that bad food and cloudy weather influenced the epidemic.

*Doña María, 859 inhabitants.*—(1st answer.) From the 13th of August to the 21st of September. (2d) By persons from infected places. (3d) Ordinary. (4th) There is none; cleaning by the municipality. (5th) Good fountain water at 1 league distance. (6th) No. (7th) Clay; no marshes nor fevers. (8th) At 400 meters. (9th) There is none. (11th) On the left of a scant river, which is dry in summer. (13th) Highway. (14th) All three. (15th) No. (16th) In canals. (17th) 39 days—ascend, 12; apogee, 10; descent, 17. (18th) Yes. (20th) 40 attacks—24 males, 16 females. (21st) 23 deaths—8 males, 15 females. (22d) All lower and to the south.

*Nijar, 13,161 inhabitants.*—(1st answer.) From the 16th of August to the 23d of September. (2d) By harvesters from Guadix and Granada. (3d) First good, second bad. (4th) Two bad canals irrigate the surrounding land; the inhabitants clean. (5th) Good spring water. (6th) No. (7th) Clay; no marshes nor fevers. (8th) At 1 kilometer. (9th) Of brick. (10th) That of 1854 greater; that of 1855 the same as this. (11th) On two small streams. (13th) By land and sea. (14th) All. (15th) Yes. (16th) In public lavatories and outside of the house. (17th) 39 days—ascend, 10; apogee, 6; descent, 23. (18th) No. (19th) No. (20th) 168 officially, but according to private counting it was double that. (21st) 37 deaths—13 males, 24 females. (22d) All in the lower. (23d) There are none.

*Adra*, 11,320 *inhabitants*.—(1st answer.) From the 16th of August to the 23d of September. (2d) It is believed to have originated in the river Adra. (3d) First bad, second miserable: (4th) No sewerage nor any public service for cleaning. (5th) Spring water; well water supplied by filtrations from the river; both fair. (6th) No. (7th) There are marshes, and fevers almost all the year. (8th) At 400 meters. (9th) In part of iron pipe and in the other part of brick. (10th) In 1855 more; in 1860 less. (11th) On the banks of the river Adra, whose stream is higher than the village. (12th) The higher part and that most remote from the river was most attacked. (13th) Highways. (14th) Fumigations. (15th) Yes. (16th) In streams and rivers outside of the house. (17th) 38 days—ascend, 11; apogee, 4; descent, 23. (18th) Yes. (19th) Yes. (20th) 1,030 attacks—482 males, 548 females. (21st) 260 deaths—111 males, 149 females. (22d) All in the lower; equally to the north and south. (23d) No attack in the post of the civil guard; among the carabineros, 12 attacks and 3 deaths. (24th) Those in good circumstances escaped; want thought to have been the cause of the increase of the epidemic.

*Pulpi*, 2,891 *inhabitants*.—(1st answer.) From the 20th of August to the 8th of September. (2d) By persons. (3d) Good. (4th) There is none; cleaning by the inhabitants. (5th) Good; well water. (7th) Sandy; frequent fevers in summer. (8th) At 500 meters. (10th) Less. (11th) Upon a dry stream. (12th) Little difference. (13th) Neighboring roads. (14th) Cordons and medicine. (15th) Only of figs. (16th) In canals and pools. (17th) 19 days; regular march. (18th) No. (19th) Yes. (20th) 15 attacks—6 males, 9 females. (21st) 8 deaths—2 males, 6 females. (22d) All in the lower.

*Alhábía*, 1,973 *inhabitants*.—(1st answer.) From the 28th of August to the 21st of September. (2d) Unknown. (3d) Both bad. (4th) There is none; cleaning by the inhabitants. (5th) River water filtered through 10 meters of sand, and collected in pipes. (6th) No. (7th) Alluvial clay; no marshes; there are fevers sometimes after rains. (8th) Within the village. (9th) Of masonry. (10th) More. (11th) At the confluence of two rivers. (12th) By two-thirds. (13th) By land. (14th) Disinfectants. (15th) Yes. (16th) In the public lavatory outside of the house. (17th) 25 days—ascend, 5; apogee, 4; descent, 16. (18th) No. (19th) Yes. (20th) 36 attacks—14 males, 22 females. (21st) 9 deaths. (22d) All in the lower. (23d) There are none. (24th) Dampness was a powerful agent in the development of the epidemic.

*Berja*, 15,586 *inhabitants*.—(1st answer.) From the 18th to the 29th of September. (2d) By persons and effects. (3d) First good, second bad. (4th) A canal crosses through the village; cleaning is easy. (5th) Good spring water. (6th) No. (7th) Alluvium; no marshes nor fevers. (8th) At 300 meters. (9th) Of brick. (10th) 1834 greater; the others equal to this. (11th) Two streams which contain water at irregular times (often dry). (12th) Equally. (13th) Highways. (14th) Disinfectants. (15th) Yes; much. (16th) In canals and running water outside of the house. (17th) 12 days; irregular periods. (18th) Yes. (19th) Yes. (20th) 80 attacks—35 males, 45 females. (21st) 21 deaths—6 males, 15 females. (22d) The majority in the lower; houses damp and in bad condition.

*Almería*, 39,567 *inhabitants*.—(1st answer.) From the 21st of August to the 7th of October. (2d) By persons from infected places; in order to be present at a public spectacle (bull fight). (3d) Both bad. (4th) There is none; night soil into the court-yards; cleaning by the municipality. (5th) The most of the drinking water is filtrated from the river and from a well; a few houses make use of water from the mountain. (5th) Suspected. (7th) Soil partly limestone, and in part detritus from the mountains; subsoil very porous and damp; very liable to considerable filtration from the latrines, etc. (8th) At 2 kilometers. (9th) There is none. (10th) This time more. (11th) Upon the river Almena and the sea. (12th) Equally. (13th) By sea and land. (14th) Cordons and lazarettos before the epidemic. (16th) The clothing is washed outside the houses, in basins and public lavatories, and in pools outside the town. (17th) 48 days—ascend, 12; apogee, 8; descent, 28. (20th) 3,185 attacks—1,583 males, 1,602 females. (21st) 1,438 deaths—457 males, 981 females. (23d) The mortality in the prison was proportionate to that of the city in general.



## PROVINCE OF MÁLAGA.

*Antequera, 25,549 inhabitants.*—(1st answer.) From the 1st of August to the 22d of September. (2d) Imported by persons or things from infected places and from distinct cases proceeding from each one of the first attacks; especially from Granada. (3d) Both bad. (4th) Miserable sewers, and the house drains are also in a miserable condition; there are sinks in each house, and the night soil is deposited in the court-yards. (5th) Springs; soft and agreeable. (6th) A public lavatory was infected by the clothing of cholera patients, when numerous cases occurred in the neighboring houses, and among those who used that water for irrigation. (7th) Situated on tertiary soil; limestone; soil very damp; malarial fevers are very frequent. (9th) Of brick and lead. (11th) Near an extensive saline lake. (12th) The damp part and that near to the Latrines suffered most. (13th) Railways and highways. (14th) Cordons, lazarettos and disinfectants. (15th) Great abuse of fruits and vegetables. (16th) In public lavatories. (17th) 53 days—ascend, 16; apogee, 10; descent, 27. (18th) Yes; the attacks and deaths increased a day after a storm. (20th) 743 attacks. (21st) 366 deaths. (22d) In a railway way station, all the inhabitants of the lower story were attacked, and none of those of the upper story, which was occupied by the chiefs. (23d) Hygienic measures of the most rigorous kind enforced in public establishments, such as hospitals, prisons, garrisons, convents, and houses of assistance, checked the spread of the cholera.

*Villaneuva del Trabuco, 1,900 inhabitants.*—(1st answer.) From the 17th of August to the 21st of September. (2d) By persons from infected places. (3d) Both bad. (4th) There is none; each inhabitant cleans. (5th) Good river water and dirty well-water; soft, containing magnesia. (6th) No. (7th) Sandy and clay; no marshes; fevers in autumn. (8th) At 280 meters. (9th) There is none. (10th) In 1855 more; in 1860 the same. (11th) On the northern bank of the river. (12th) Equally. (13th) Neighboring roads. (14th) Disinfectants, lazarettos, and inspection. (15th) Abuse of vegetables. (16th) In the river and streams. (17th) 35 days—ascend, 14; apogee, 8; descent, 13. (18th) No. (19th) Yes. (20th) 62 attacks—25 males, 37 females. (21st) 40 deaths—13 males, 27 females. (22d) In the lower, 56; in the upper, 6; to the north, 25; to the south, 37.

*Ronda, 19,181 inhabitants.*—(1st answer.) From the 24th of August to the 22d of October. (2d) Suspected by persons from the town of Canete la Real. (3d) Good in general; although the houses of the first attacked are in bad hygienic condition. (4th) Very scanty sewerage, in bad condition. The night-soil is thrown into the streets; no public cleaning. (5th) Springs in ordinary condition; they contain carbonate and phosphates of lime; hard. (6th) River water, which is used for washing and other domestic purposes. (7th) Tertiary formation; limestone, rocky; no marshes nor intermittent fevers. (8th) At 700 meters to the north. (9th) Of iron pipes. (10th) This time more. (11th) A small river; the Guadalevin traverses the town. (12th) Equally. (13th) Highways and neighboring roads. (14th) Cordons, lazarettos, and disinfectants. (15th) Much abuse of fruits and vegetables; many cases occurred among the venders of cantaloupes. (16th) In the river; during the cholera, the well-to-do families had the washing done in the houses. (17th) 60 days. (18th) After a great storm, which occurred on the 28th of August, some increase in the epidemic was noted. (19th) Yes. (20th) 84 attacks. (21st) 37 deaths—15 males, 22 females. (22d) In general; in the upper and lower. (23d) No case occurred in the prison, in the beneficiary asylum, or the post of the civil guard. (24th) The number of concealed cases is calculated to be double the deaths.

*Riogordo 3,459 inhabitants.*—(1st answer.) From the 15th of September to the 27th of October. (2d) By effects from infected places. (3d) Both. (4th) A single pave sewer runs from the north to the south through the village, and is uncovered in its last half. The night-soil goes into the court-yards. (5th) Generally used river water; good, containing lime. (6th) River water. (7th) Calcareous and clay; no marshes; intermittent fevers are frequent. (8th) At 50 meters. (9th) There is none. (10th) This time less, due to hygienic measures. (11th) Upon the river Guaro. (12th) The number of attacks was greater in the field laborers exposed to the dampness and emanations from the soil. (13th) Neighboring roads. (14th) Cordons and disinfectants. (15th) Abuse of fruits and vegetables. (16th) In the river.

(17th) 42 days—ascend, 7; apogee, 16; descent, 19. (18th) On days following storms and rain, and in general after damp weather, the attacks and deaths increased; foggy nights were frightful. (19th) No. (20th) 450 attacks—150 males, 300 females. (21st) 130 deaths—50 males, 80 females. (22d) Generally in the lower stories. (23d) One attack in a woman in the post of the civil guard.

NOTE.—In the village of Tevar there were only 3 attacks and 3 deaths.

#### PROVINCE OF CÁDIZ.

*Puerto Real*, 9,638 inhabitants.—(1st answer.) From the 11th of July to the 15th of September. (2d) It is supposed by a sailor from an infected place. (3d) Both bad. (4th) There is none; there are only sinks which are periodically cleaned; the municipality is charged with the cleaning. (5th) Spring water; good, containing lime. (6th) No. (7th) Tertiary soil, sandy and clay; there are marshes near the town. Malarial fevers in summer. (8th) Within the town. (9th) Of masonry and brick. (11th) On the seashore. (13th) Land and sea, and rail. (14th) Medical inspection and disinfection. (15th) No. (16th) Washing in the houses. (17th) 66 days—ascend, 28; apogee, 20; descent, 18. (18th) During the cholera it rained one day, and from this time the cholera rapidly began to develop. (19th) No. (20th) 129 attacks—52 males, 77 females. (21st) 79 deaths—33 males, 46 females. (22d) In general in the lower stories and to the south. (23d) There is no post.

*Cádiz*, 60,280 inhabitants.—(1st answer.) From the 1st of August to the 13th of October. (2d) Imported from Puerto Real. (3d) First, good; second, bad. (4th) The sewerage is old but good; the filth goes into the sea; cleaning by the municipality. (5th) Spring water from a distance, collected in large earthen jars; contains lime and magnesia. (6th) No. (7th) Soil calcareous; subsoil clay mixed with sand-stone and rock; no marshes nor fevers. (8th) At  $1\frac{1}{2}$  kilometers distance. (9th) Iron pipes. (10th) That of 1833 less; that of 1854 more; in 1865 there was none, in spite of its being at Sevilla and Jarea. (11th) Surrounded on all sides by the sea; only a narrow strip of land connects it with San Fernando. (13th) Rail, land, and sea. (14th) Places of inspection, medical, disinfection of baggage. (15th) No. (17th) 74 days—ascend, 35; apogee, 12; descent, 27. (18th) Sometimes increase of the epidemic was observed after showers. (19th) Yes. (20th) 1,388 attacks—583 males, 805 females. (21st) 554 deaths—246 males, 308 females. (22d) The majority in the upper stories, because they are inhabited generally by the poor people; exposed to the south and east. (23d) In the garrison, due to carefulness, the mortality was a half of 1 per cent., while in the town it was 1 per cent. (24) In the prison and in the hospital of San Juan de Dios, in spite of its being located in one of the wards which suffered most, there were no attacks; considered due to the excellent hygiene and system of isolation used.

*Tarifa*, 11,962 inhabitants.—(1st answer.) From the 21st of January to the 22d of March, 1886. (2d) By contraband goods sent to a peasant, who was the first attacked; the latter used the clothing from an infected place. (3d) First, bad; second, miserable. (4th) Badly constructed system of sewerage, giving place to the escape of filtrations into the public and private drinking wells; it empties into a stream which traverses the town. (5th) Wells and fountains, of good quality, containing lime. (6th) Contamination between the drinking wells and those for sinks was suspected. (7th) Calcareous clay; soil very damp. There are marshes, and malarial fevers are frequent. (9th) Brick. (11th) On the Strait of Gibraltar. (12th) The ward beyond the walls suffered the most, and those who used fountain water suffered much less. (13th) By land and sea. (14th) Disinfectants and fumigations. (15th) Abuse of salads, and of a dish made of bread, oil, vinegar, salt, red pepper, mixed in water (gazpacho). (17th) 59 days—ascend, 11, apogee, 5; descent 43. (16th) The commencement of the epidemic coincided with rainy and stormy weather. (20th) 443 attacks. (21st) 203 deaths. (23d) Neither in this nor in the former epidemic was the island of Palomas, a half kilometer distant from the town, invaded by cholera. (24th) The poorer quarters were those which suffered most, on account of want and of the great dampness of the houses.

NOTE.—The garrison and their families, and the employés of the light-house, 150 inhabitants altogether, occupied the island of Palomas. The soil of this island consists of strata



of marine formation, very rich in fossils, which stand several meters thick, above a subsoil of sedimentary rock. The garrison and the people in the fort are supplied from a large open reservoir cut in the rock containing limpid and pure water. The inhabitants of this rock have never been invaded by an epidemic of cholera.

*La Línea (the Lines near Gibraltar)* 9,169 inhabitants.—(1st answer.) From the 14th of August to the 17th of October. (2d) Unknown. (3d) First, ordinary; second, bad. (4th) There is none; public cleaning at the charge of the municipality; night-soil into the court-yards. (5th) Spring and well water. (6th) No. (7th) Sandy soil; subsoil calcareous. (8th) Near the town. (9th) There is none. (10th) There was none in 1865; this time more than in 1834; since the latter period the population has tripled. (11th) On the sea-shore. (12th) The ward near the sea suffered most. (13th) By land and sea. (14th) Disinfectants, isolation, and burning of clothing. (15th) Abuse of fruits and alcoholic beverages. (16th) In the houses. (18th) No. (19th) Yes. (20th) 429 attacks—205 males, 224 females. (21st) 206 deaths—96 males, 110 females. (22d) The majority dwelt in the lower.

#### SUMMARY OF REPLIES TO INTERROGATORIES CONCERNING CHOLERA IN SPAIN.

A general examination of the foregoing analysis of official replies to interrogatories concerning the epidemic of cholera in Spain during 1885, addressed by the Spanish Government to all the cities and villages of that Kingdom which had been visited by the scourge, shows the following facts:

This analysis embodies information relating to 582 towns, and the course of cholera therein; it furnishes important data relating to upwards of two million persons scattered over the whole country, liable to contract the disease; comprises statistics more or less detailed of various conditions and circumstances of 80,776 attacks of cholera, and 29,387 deaths therefrom.

*Replies to question No. 2.*—As to the mode of origin of the disease, the reports from 141 villages declare it to be unknown; those from 340 villages state that it was introduced by persons from infected places; those from 49 villages affirm that it was introduced by contaminated personal effects; those from 25 villages admit that the disease was due to contaminated water of small rivers or irrigation canals. It should be stated in this connection that occasionally the disease was introduced by two or more of these means.

*No. 3.*—As to the general hygienic conditions of the localities invaded by the epidemic, 279 reports state that they were good; 197 say they were bad; and 91 claim that they were ordinary. As to the hygienic conditions of the particular dwellings of the first attacked, 113 reports defined them as good; 348 declared them bad; and 87 pronounced them ordinary.

*No. 4.*—As to sewerage: 52 towns report the existence of a very imperfect system of sewers, in bad condition; 523 towns possess no sewers; in 149 towns it is stated that the removal of sewage and other kinds of filth is done under direction and at the cost of the municipality; in 214 towns it is stated that there is no disposal of sewage, excrement, etc., other than by the cleansing of the rains of heaven, unless the individual inhabitants are disposed for their own profit to remove the filth for manure.

*No. 5.*—As to the source of the drinking water, 372 towns use spring water; 126 use well water; 191 use river water; 21 use water from irrigation canals; 16 use rain-water collected in cisterns, sometimes above, but mostly underground. As to the quality of the drinking water, in 354 instances it is declared to be good; in 29 it is said to be bad; in 22 it is claimed to be of medium quality.

*No. 6.*—In the reports from 107 towns it is stated that contaminated drinking water supplied the houses in which the first outbreak of cholera occurred, and was believed to be the cause of the disease; in 396 reports it is affirmed that the drinking water was not charged with responsibility for the first spread of the disease.

*No. 7.*—As to the character of the soil: In 303 towns clay was a constituent; in 256 rock was a prominent feature; in 190 sand predominated. As to the presence in the immediate neighborhood of marshes, lagoons, or swamps: They were present in 70 instances; they were absent in 353. The prevalence of intermittent fevers, especially in autumn, is mentioned in 210 reports; their absence is stated in 313 reports.

No. 8.—As to the location of the cemetery: The average distance from the center of the town was found to be about two-thirds of a kilometer.

No. 9.—As to the means of conduction of the drinking water into the town: In 342 instances there were no means; in 145 cases these were closed conduits of terra-cotta, brick, or masonry; in 48 instances there were iron pipes; in 22 there were lead pipes; and in 17 towns the drinking water was stated to be brought in through irrigation canals.

No. 10.—The towns were more afflicted by the scourge formerly in 210 instances; less afflicted formerly in 172 cases.

No. 11.—The town was located upon a river in 245 instances; upon one or more small streams in 141 cases; upon the sea in 10; upon one or more large irrigation canals 35 times.

No. 12.—The part of the town nearest the river, stream, or canal was stated to be more affected by the epidemic than the rest of the town in 130 instances, less in 45 cases, and equally in 179.

No. 13.—The means of communication between the town and other infected places were: 126 times by railway; by sea, 23 times; by river, 18 times; by land, 559 times.

No. 14.—Of the preventive measures: Disinfectants were employed 425 times, cordons 177 times, lazarettos 116 times, either singly or two combined; all three of these were used in 78 instances; isolation, either singly or in conjunction with one or more of the others, in the case of 85 towns.

No. 15.—The abuse of fruits by the inhabitants is stated to have occurred in the case of 451 towns; it is stated that there was no such abuse in the case of 247 towns.

No. 16.—As to the washing of clothes: The custom of washing within the dwellings prevailed 108 times; the opposite custom of giving the washing out prevailed 81 times; public lavatories existed in 158 instances; the custom of washing the clothing in the rivers or small streams prevailed 350 times, in the irrigation canals 64 times, in the fountains 13 times, and in private basins (usually stone) 43 times.

No. 17.—The average duration of the epidemic was 56 days per town, with a rise of 20 days, a stationary period of 11 days, and a gradual fall of 25 days.

No. 18.—The greatest mortality is stated to have coincided with storms and rains in 279 instances, and it is affirmed that it did not so coincide in 243 instances.

No. 19.—Tendency to diarrhœa or to intestinal disturbances prevailed among the inhabitants previous to the outbreak of the epidemic in the case of 382 towns; it is stated that there was no such tendency in 128 towns.

No. 20.—The average population embraced in these official documents is 401 inhabitants per town. Of this number the average percentage attacked by cholera was 34.91. Of the cholera attacks, 56.92 per cent. were in females; whilst only 43.08 per cent. were in males.

No. 21.—There was a mortality among the attacked of 36.38 per cent. Of the deaths, 61.36 per cent. were in females, whilst again only 38.64 per cent were in males.

No. 22.—Although in the majority of Spanish towns of this average population, the dwellings have usually only one story, in quite a number of the villages the houses are of two and sometimes three stories. In 310 towns the majority of the attacks were in people living in the lower stories or in basements; in 77 towns the majority of those attacked lived in the upper stories; and in 48 towns the inhabitants of the upper and lower stories were equally attacked. In 131 towns the majority of the attacked occupied rooms facing to the south; in 65 the majority of the rooms of victims faced to the north; whilst in 63 towns there was no difference in this respect.

No. 23.—In 298 towns there were no military or penal establishments. In 73 towns there were such establishments and in these usually the percentage of invasions was considerably less than that in the surrounding populations.

There are several points in this summary which should be somewhat elucidated and others which are more or less noteworthy. Although these reports declare in the majority of instances that the general hygienic conditions of the town invaded were good this declaration must be taken with a great many "grains of allowance." What has been thus declared "good" in



Spain is only relatively so. The same conditions in English or American towns would be described as either "bad" or only "ordinary." As a rule in estimating the value of such terms, it would be well for the American or English reader of this analysis to regard such terms as equivalent to "not so bad." This especially applies to the description of the quality of the drinking water, for with the greatest rarity can it be justly denominated as "good," yet in the majority of instances it has been so described.

Again, with regard to sewerage and the disposal of sewage, the replies do not state half the truth. Although fifty-two towns report the existence therein of a more or less extensive system of sewerage, it can be fairly stated that there is not a town in Spain with which I am personally acquainted or of which I possess trustworthy information, save the city of Madrid, which has a system of sewerage worthy of the name. When the so-called sewers exist at all their extent is ridiculously limited and their condition is, almost without exception, such as to render them useless or abominable, oftentimes even dangerous to the public health. And as to the disposal of the household sewage and other refuse material it may be taken for granted that the local officials who have made these reports have exposed therein as little as possible the real truth, which indeed is frequently enough revolting. The usual statement that the cleansing of the town is done by the inhabitants, when justly translated means that such matters are abandoned to the purifying action of storms and to the interests of those agriculturists who desire to annually enrich their soil with manure at little cost.

Concerning measures of prevention: disinfection, cordons, lazarettos, isolation, were the means resorted to, and in the order of frequency above recorded. It may be stated that, in general, the disinfection was perfunctory in the extreme; that the cordons were very tardily established and easily penetrated; that the lazarettos were inadequate and badly managed; and that the isolation was not complete or resorted to with sufficient promptness.

The washing of clothing in Spain, as it usually does in other countries, played an important rôle in the dissemination of the seeds of the epidemic. The custom of washing the clothing in rivers or small streams prevailed in the great majority of instances. In fact this contamination of streams, fountains, wells, and irrigation canals by the soiled personal effects of cholera patients was almost universal, and it is not at all surprising that the epidemic, having once gained a firm foothold in Spain, so severely ravaged that country from one end to the other. What has already been said in a former part of this section respecting the water supply, public and private hygiene, and the manners and customs of the people will make this readily understood.

This analysis shows that the state of the weather exercised but little regular influence over the development of the disease or the course of the epidemic.

It appears that there was in most of the towns a tendency of the population to diarrhoea or to other intestinal disturbances previous to the outbreak of the epidemic therein.

The statistics embraced in this analysis show that 34.91 per cent. of the population of the infected villages was attacked with cholera, and that among those attacked there was a mortality of 36.38 per cent. The most noteworthy point concerning these figures is, however, that the brunt of the misfortune fell far more heavily upon the females than upon the males. The reason of this difference is difficult of explanation, unless it be the fact that so many of the women were engaged in handling and washing the soiled clothing.

#### GENERAL REMARKS CONCERNING CHOLERA IN SPAIN.

Although the Kingdom of Spain was invaded by cholera during the summer of 1884, the disease was limited to the province of Alicante, unless we admit that some few cases of a suspicious character in the city of Toledo, which caused great alarm in that municipality, were genuine examples of the Asiatic scourge. Whether these alarming cases in Toledo were or were not Asiatic cholera, their origin was traced to the districts in the province of Alicante, where the disease then had an undoubted existence.

It seems pretty well established that the origin of the cholera of 1884 in the province of Alicante was due to importation indirectly from the south of France, where an epidemic was

then prevailing, through a family of refugees with their personal effects, who had sailed first to the French province of Oran, on the northern coast of Africa, and thence by a fishing smack to a small maritime village on the eastern coast of Spain, near the city of Alicante, the capital of the province of the same name, where they and their effects evaded the quarantine and surreptitiously entered the country.

It is also very certain that from the limited epidemic which followed, the disease reached Gandía, a small town in the southern and maritime portion of the adjoining province of Valencia, towards the end of the autumn and lingered through the winter in that neighborhood in the form of scattered "suspicious cases," until the middle of the spring of 1885 when cholera suddenly broke out and rapidly spread as an active epidemic in the not very distant town of Játiva, also located in the southern part of the province of Valencia. From this point the disease quickly spread far and wide, at first chiefly through the movements of agricultural laborers from this cholera-stricken district, as it had been carried in the first place to Játiva from the infected neighborhood of Gandía.

The history of the origin and spread of the great epidemic of 1885 in Spain is like the invasion and march of almost all other cholera epidemics. On the appearance of the first cases there was great doubt as to the real nature of the disease, the municipal authorities and the local physicians strenuously repudiating the suspicion that Asiatic cholera had broken out in *their* community, meantime naturally neglecting to adopt proper precautionary measures against the development of a possible epidemic. All sorts of names but the real one were given to the disease, whilst numbers of the frightened inhabitants with their personal effects early seized the opportunity to flee before the enclosure of the town by the hated *cordon sanitaire*. Tardily the place is officially proclaimed to be infected with Asiatic cholera and is isolated from the rest of the world by a sanitary cordon under authority of the government. Not only does this "isolation" come late, but even after it is accomplished ingress and egress take place without very great difficulty. The epidemic spreads, leaping over this slight barrier and defying the insignificant restraints of fumigation of travelers and of their detention in lazarretos, and in a short time becomes one of the most devastating Spain has ever experienced.

There are several reasons why the force of the epidemic fell more heavily upon Spain than upon other European countries. One of the principal of these was that the true nature of the disease was for so long a time either misunderstood or systematically concealed, thus rendering it possible for scattered foci of infection to become firmly established before any effective means of restriction were devised and employed. By the end of the spring of 1885 the seeds of the epidemic had been broadly strewn from these foci of infection over the greater part of the Kingdom mainly by the movements of agricultural laborers and refugees from the infected southern portion of the province of Valencia, and this had already, to a great extent, taken place before the enforcement of any vigorous or effective means of limitation. Cholera does not originate *de novo* in Spain, notwithstanding the nearly universal violation of the most fundamental principles of public and private hygiene in that country, else it would no doubt be endemic there as it is in Lower Bengal, for the drinking water is but little less polluted in the former, the disposal of the household filth but little less objectionable, and the manners and customs of the people but little less conducive to the production and propagation of such a disease. But what has been said more or less in detail of the very pronounced unhygienic conditions almost universally prevailing in Spain at the time of this wide-spread dissemination of the seeds of the disease, constituting that country a well prepared soil, explains, I think, very satisfactorily the rapid and uncontrollable development of the epidemic and the exuberant harvest of death which was reaped there in 1885.

A comparison of this country with Egypt, France, and Italy shows at a glance one thing common to all—the wide prevalence of squalor among the general population. In this respect the condition of Spain was somewhat worse than that of either France or Italy; it was somewhat better than that of Egypt. Again, in respect to proper appreciation and application of the fundamental principles of hygiene by municipalities and by individuals, the situation of Spain was something worse than that of France or Italy and a little better than that of Egypt.



As regards the permanent establishment and efficiency of organizations for the care of the public health, Spain was much worse off than was France or Italy; she was perhaps on a par with Egypt. Concerning the important matter of pure, wholesome, uncontaminated drinking water, again France and Italy had the advantage of Spain; whilst Egypt, being dependent almost entirely upon the Nile and the irrigation canals leading from it, was in a peculiar situation. In the description of the water supply of the city of Murcia in Spain, it will be remembered that most of the drinking water was collected by the citizens from the river Segura during the spring freshets and stored in great earthen jars for use during the rest of the year; and by reference to the foregoing account of manners and customs of the Spanish people, it will be seen that this custom of collecting and storing drinking water for future use was not infrequent in many localities in the south of Spain, where the Moors had lingered longest and naturally left most impress of their peculiarities upon the mode of life of the inhabitants. In Egypt this custom of storing the drinking water at the period of the rise of the Nile is very prevalent. It is perhaps the extent of this custom of water storage by the individual inhabitants of Egypt more than any other circumstance which explains why the recent epidemic of cholera has so frightfully ravaged Spain whilst Egypt suffered less. Of course there are many modes of disseminating cholera, but it is very clear that the rapid spread of an epidemic of this disease in a locality after it has been once introduced is most frequently due to infection of the drinking water by the washing of clothing soiled with cholera discharges, or more directly, though less frequently, by the alvine evacuations themselves. Of two countries, the one depending for drinking water mainly upon small streams and irrigation canals liable to contamination, as was Spain, the other depending for drinking water mainly upon that stored long before the appearance of the epidemic, as was Egypt, we should expect the ravages of the epidemic to be greater in the former.

The cholera epidemic of 1885 in Spain is notable, among other things, for a very extensive effort to protect the inhabitants of a great number of villages from attack and death by cholera, as well as to shorten the duration of the epidemic without recourse to the harrowing infliction of *cordons sanitaires*, maritime quarantines, isolations, fumigation of travelers, etc. I refer to the wholesale inoculations of inhabitants with the supposed virus of Asiatic cholera by Dr. Jaime Ferrán and his associates. This matter will be discussed at some length in a subsequent chapter, to which those desirous of information concerning the facts are referred.

#### REVISITATION OF SPAIN BY CHOLERA IN 1890.

Whilst this report is passing through the press news is published in America through the secular and the medical press of the reappearance of Asiatic cholera in the Kingdom of Spain, and the gradual development in that country of another wide-spread epidemic of that disease. At the present moment cholera seems to have found a lodgment and to be spreading in no less than four of the provinces on the eastern Mediterranean coast, namely, Valencia, Alicante, Murcia, and Tarragona. It is difficult, however, to obtain exact information relative to the extent of this outbreak, but it appears to be serious. The former course of vacillation and concealment followed by the municipal and provincial authorities is again being practiced, whilst the frightened inhabitants are fleeing to distant localities, and probably carrying with them without restraint the seeds of another great epidemic. The hygienic condition of Spain is to-day but little better than it was in 1885. In fact, during the years immediately succeeding the epidemic of the latter year general and individual hygiene were even in worse straits than before, on account of the financial exhaustion occasioned by the great draughts upon the treasuries of the municipalities of the affected districts, and it does not seem that any general movement has been since inaugurated looking to radical improvement.

It seems, therefore, that Spain is a second time within a decade to be the victim of a severe epidemic of Asiatic cholera, unless indeed the influence of the former infection is still sufficiently powerful for her protection.

The extent of this last epidemic has become so great already that there seems to be danger of another very general invasion of the Mediterranean countries of southern Europe.

The origin of the outbreak in Spain in 1890 is quite obscure, according to my information. There seem to be three conflicting stories, each of which lacks a satisfactory basis. There is no doubt that the disease first appeared in the village of Pueblo de Rugat, in the province of Valencia, a village which suffered also from the epidemic of 1885. Here, however, accounts differ. One relates that whilst tearing up for sanitary improvements certain streets in the neighborhood of the cemetery where the cadavers of the victims of the epidemic of 1885 were interred, the disease suddenly appeared among some children and women in the immediate neighborhood, a recrudescence from the old germs buried in the cholera cemetery, and that the epidemic spread from these. Another rumor accounts for the sudden outbreak of the disease in Pueblo de Rugat by introduction of the cholera germs in the soiled clothing of some soldiers returning from a Spanish colony on the northern coast of Africa. And still another rumor is that the cholera was brought to this village by some travelers from the East. Whatever the true explanation may be, it is now certain that the disease of Pueblo de Rugat was genuine Asiatic cholera, notwithstanding the repeated denials of the local and of the general authorities which were at first so widely published.

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## SECTION 5.

### CHOLERA IN GREAT BRITAIN.

#### ABSTRACTS OF UNITED STATES CONSULAR REPORTS.

##### CHOLERA AT CARDIFF, GREAT BRITAIN, 1884.\*

A great many alarming rumors have passed current in this port and district since the outbreak of cholera at Marseilles. Considerable traffic is carried on between the infected French port and the British Channel; anxiety regarding the epidemic, and dread lest it should be imported to South Wales, were to be expected. All sorts of panic-inspiring reports floated about from day to day. I was once informed by a gentleman of position in town that a cholera ship, with dead and dying on board, had been permitted to enter Rute Dock unchallenged. I mention this instance as a sample of what was said, and as indicating what the state of the public pulse must have been when reports of that character were promulgated by men who ought to know, and whose business it was to be accurate. But the facts in connection with the threatened introduction of cholera to this port and the measures adopted to prevent the same are as follows:

The first cholera alarm was in connection with the steamship *Carthagena*, which left Marseilles the first week in July, with two men suffering from choleraic diarrhœa. One was ill for twelve hours, and the other for about twenty-four. But both recovered before the vessel arrived in Cardiff Roads on the 11th of July.

Alarming rumors concerning the *Carthagena* had preceded her, and the sanitary tug-boat had been on the lookout for the vessel for several days previous to her arrival.

She was detained in the Cardiff Roads four days, during which time both the crew and the vessel were thoroughly overhauled and examined. The crew was found to be in good health; no case of cholera had broken out on the vessel, and she was allowed to proceed to dock. The next case occasioning alarm was that of the *Granville*.

This steamer left Marseilles on the 23d of July. Soon after her departure one fireman died after a very short illness, the symptoms indicating cholera. This vessel was intercepted in the Cardiff Roads and subjected to a thorough examination. She was disinfected, and after a quarantine of five days was allowed to proceed to dock.

Further alarm was occasioned by the arrival of the *Rishauglys* from Marseilles. She entered that port with grain. After discharging her cargo she was removed to another part

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\* Report by Evan D. Jones, United States consul, August 13, 1884.



of the docks or harbor, where the sewage of the town discharges itself. Two cases of cholera occurred on board while the vessel was at Marseilles. The men were immediately sent to hospital, and the vessel proceeded to Cardiff on 25th July. She was intercepted in the roads on the 3d August, but no sickness was found on board. The vessel has been disinfected under the direction of the medical officer, and the crew have been daily inspected, but no case of cholera or any sickness has occurred. The captain of the *Rishauglys* had slight stomachic complaint which has now disappeared, but he was kept upon the Flat Holms, an island in the roads, during convalescence. There is no cause for anxiety respecting him. The vessel was released from quarantine and entered the dock on Monday last, the 11th August.

Regarding the precautions taken by the authorities, I would say that all vessels from the Mediterranean, the Baltic, Black Sea, Sea of Azof, the Sea of Marmora, directly or indirectly, or from any other port where cholera has appeared, or any vessel carrying goods or persons from vessels coming from the ports or places aforesaid, are challenged, and the master is required to furnish all information as to the port from which he sailed, the state of sickness at such port or ports, the condition of the crew during the voyage, the present state of the crew, and the nature of the sickness, if any. Stringent regulations are in force compelling pilots and quarantine officers to remain on board vessels where sickness prevails until such vessel is discharged from quarantine.

Vessels arriving with clean bills of health display a large yellow flag by day, and a signal lantern, such as is commonly used on board Her Majesty's war-ships, in the night-time. Vessels without clean bills of health display a yellow flag with a circular black mark or ball thereon in the day-time, and a lantern, as used by vessels with clean bills of health, by night. Vessels with cholera on board are required to display a flag of yellow and black at the main-topmast head in the day-time, and two lanterns, one over the other, at night.

Vessels with unclean bills of health are boarded, so as to ascertain if the whole of the crew are in good health. If so, the vessel is allowed to enter the docks; if any are sick she is detained by the officer for twelve hours to enable the medical officer of health to visit the ship and make an inspection. If he finds that the crew has suffered from cholera, the vessel is disinfected by means of burning sulphur in every compartment, to the extent of 1 pound per 1,000 cubic feet space. The wood-work of all cabins is thoroughly washed with a solution of McDougall's soluble powder of carbolate of lime in a proportion of 2 ounces to each gallon of water. The bedding and soiled clothing of the sick are destroyed, and the ballast water and bilge water removed and replaced by fresh water. Accommodation has been provided for cholera cases on the island already named, should any make their appearance.

Similar precautions have been taken and like regulations prevail at Swansea and Newport.

It is satisfactory to add that this community is at present in a calm state of mind concerning cholera. Cardiff occupies a flat situation, and the climate is therefore often sultry, and notwithstanding the fact that the sewage and sanitary arrangements are good in most sections of the town, a general impression prevails that should the cholera appear here it will prove destructive to the inhabitants, as it has done during previous visitations. It has been decided to throw water charged with carbolate of lime down the sewers and ventilators of Roathe, a district of Cardiff, where injurious gases are reported to be escaping. The vigilance of the authorities and the firmness and capacity displayed by Dr. Paine, the medical officer of health, are deserving of all praise.

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FATAL CASE OF CHOLERA AT CARDIFF.\*

A fatal case of cholera having occurred at this port under exceptional circumstances, the following particulars relating to the same are reported: The steamer *Crandan*, of Newport, arrived in Penarth Roads off Cardiff, from Barcelona, a foul port, on Wednesday, September 2. She was examined on Wednesday, and the crew having been found all well, the vessel

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\* Report received by the Department from the consulate at Cardiff, Great Britain, dated September 8, 1885.

was admitted to the east dock, Cardiff. The crew was put off on the same day, and it was expected that the steamer would be laid up. On Friday a fresh crew was shipped. A member thereof, named James Richards, went on board the vessel about 5 o'clock in the afternoon and, after severe exertion at the donkey-winch, drank some of the water which had been taken on board at Barcelona. He was soon after seized with vomiting, cramp, and choleraic symptoms, and died about 9 o'clock that night. Medical inspection having been made, it was decided that the man had died from cholera. The steamer *Crandan* was then towed out of the dock the next tide to a quarantine station and disinfected. The body of the man Richards was at once wrapped in a sail weighted with stones and towed down the channel, where it was thrown overboard. All the other members of the crew were examined by the medical officer of health and found free from disease.

Upon receipt of intelligence concerning this case, the Local Government Board dispatched a medical inspector to Cardiff, and precautions and safeguards against the spread of the disease have been taken under his direction.

When the steamer *Crandan* was boarded on her arrival in Cardiff Roads, on Wednesday, September 2, the quarantine inspector made various inquiries of the master, and was informed, first, that there had been no sickness on board during the voyage; and, second, that no water shipped at Barcelona was then in the ship. Upon subsequent inspection and inquiry, however, it was found that members of the crew had suffered from diarrhoea during the voyage, and that two casks of bad water were still on board, when the vessel was sent back from the East Bute dock, Cardiff, to the quarantine station.

Efforts are now being made to ascertain the whereabouts of the discharged crew shipped at Glasgow, who made the voyage from Barcelona to Cardiff, in order that they may be visited and their condition inquired into.

The ship *Crandan* has already been three times disinfected at this port, and Dr. Paine, a vigilant officer of health, has now directed that the ship be admitted to dock this (Tuesday) morning, on condition that her water-tanks shall be emptied and thoroughly cleansed with spring water before her admission. Dr. Paine is of opinion that the fatal case is one of sporadic cholera, and does not believe that the disease is at all likely to spread unless the members of the crew who left the vessel at Cardiff were affected with the epidemic.

#### PREVENTION OF CHOLERA.\*

There is no longer a doubt but that Asiatic cholera is epidemic at Toulon, and as the English Government trusts rather to sanitary precautions than to quarantine, it is considered certain by the best authorities that at least some cases will occur in England, though it is hoped that no epidemic will ensue, as municipal regulations are of such unquestioned excellence and as the science of preventive medicine has made such great strides since the last outbreak.

This dreaded scourge having, however, obtained a foot-hold in Europe, there is grave reason to fear that the United States can not escape; and I therefore inclose a pamphlet which has had a wide circulation in England, and which has been commended most highly by the medical profession generally as containing in a most concise form certain necessary precautions the observance of which reduces the danger of spreading contagion to a minimum.

The author of this pamphlet, Dr. Davies, has been medical officer of health to the municipality of Bristol for nineteen years. He enjoys a wide reputation throughout Great Britain for his attainments in that special branch of medicine known as preventive medicine, and he has had experience in several outbreaks of cholera.

I hope and trust the United States will escape all contagion, but it behooves us literally "to put our house in order." The pamphlet is as follows, and is introduced among other reasons to show the belief in the infectious nature of the disease:

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\* Report by the United States consul at Bristol, July 2, 1884.



## "BRISTOL SANITARY AUTHORITY—PREVENTION OF CHOLERA.\*

"As Asiatic cholera is now reported in France, and may possibly reach this country, these remarks and suggestions are published with a view to prevent its spread should it unfortunately be introduced.

"(1) There is no reason to believe that this disease has ever arisen spontaneously in this country, but, when once imported, it spreads by infection, in a manner peculiar to itself, unless prompt means are taken to prevent it.

"(2) The discharges from the stomach and bowels of a patient suffering from cholera or choleraic diarrhœa are the chief, if not the only, source of infection. These discharges, if thrown into the drains without previous disinfection, contaminate the public sewers, and, by percolation through the ground, pollute the adjacent surface wells; also, if allowed to dry on linen, on the surface of the ground, or elsewhere, they will spread the disease.

"(3) To prevent cholera obtaining a foot-hold among us, see that all closets, privies, and sinks in your house are well "trapped," and that the traps are in good working order, and let each closet or privy be flushed at least once daily with abundance of water. One of the common disinfectants must then be sprinkled freely over the sides and bottom of the pan or receiver.

"In the case of schools, factories, and other large establishments, it is advisable to use, in addition, one of the fluid disinfectants for flushing. (See appendix.)

"(4) Be very careful, in times of cholera, what water you drink. All pump and shallow well water is, without exception, highly dangerous. If such water must be used, boil thoroughly for fifteen minutes before drinking. Filtration is not a sufficient safeguard against the introduction of the cholera poison.

"(5) If a case of cholera or choleraic diarrhœa should appear in your house, let *all discharges* from the patient be received *at once* into a strong chemical disinfectant, liquid or powder (see appendix), and let a further quantity of the disinfectant be added before the discharges are thrown into the drain. The sick-room must be well ventilated. If the bedding should become soiled by any discharge, sprinkle some carbolated powder freely over it. All linen soiled by cholera discharges should be burnt as soon as possible. In case of death, let the corpse be laid in a coffin, covered with carbolated powder, and speedily buried.

"(6) When cholera is about it is advisable to use preventive measures in every case of diarrhœa, however slight, as it is occasionally difficult to distinguish the true Asiatic cholera (in a mild form) from ordinary non-specific diarrhœa, and yet the mildest case of true cholera will prove highly infectious. Should a case appear in your house, send at once for your usual medical attendant, and send also notice of the case to the medical officer of health, 13 Prince street.

"(7) Finally, remember that cholera is transmitted from person to person by the infectious discharges, which may, owing to defective drains, contaminate drinking water, or may spread the disease by infecting the air. Therefore, devote all your energy to destroying these *at once and completely* by receiving them into and covering them with strong disinfectants.

"If these directions are faithfully attended to, persons may nurse the sick with confidence, and all danger of cholera spreading will be reduced to a minimum, if not entirely precluded.

## APPENDIX.

"The following disinfectants are useful for the above purposes; care should be taken in the use, as some are poisonous and corrosive; they may be obtained at all chemists:

"For flushing closets and drains:

"(a) Carbolic acid (No. 5), 1 pint to 4 gallons of water; Jeyes's disinfectant, 4 ounces to 4 gallons of water; bisulphite of lime, 4 pints to 4 gallons of water; Burnett's fluid (chloride of zinc), 1 pint to a gallon of water; green copperas, or sulphate of iron, 2 pounds dissolved in a bucket of water; chloralum, 1 pint to 2 gallons; Calvert's, or MacDoygall's, or Austin's carbolated powder, for sprinkling over pan, over soiled bedding, or over dead bodies.

\* By David Davies, Medical Officer of Health, June, 1884.

“For soaking linen, which transfer soon to clean water:

“(b) Carbolic acid (No. 4), 1 pint to 5 gallons of water; Jeyes's disinfectant, 4 ounces to 5 gallons of water; chloride of lime, 2 table-spoons to a gallon of water; bisulphite of lime, 1 pint to 5 gallons of water.

“A little red Condy's fluid (about 2 tea-spoonfuls in a basin of water) is useful for washing the hands or bathing the patient.

“The best gaseous disinfectant for unoccupied rooms is sulphurous acid gas, which may be prepared and applied as follows:

“In a small cast-iron plumber's pot, in the room to be disinfected, put a pound or more of sulphur, and throw on it a shovel-ful of live coals. The windows and chimney having been secured with paper and paste, shut the door and keep the room closed for twelve hours or longer. Infected articles of clothing may also be disinfected by leaving them spread on ropes in the room while the gas is generated.”

#### REMARKS ON THE POLICY OF PROTECTION AGAINST CHOLERA IN ENGLAND.

Although it appears to be the policy of the British Government not only in India, but also as a rule throughout the world, to disseminate a belief in the non-infectiousness, non-contagiousness, and non-transportability of Asiatic cholera, and to induce other sovereign powers to act upon such a belief to the extent of abolishing combative measures against the introduction and spread of the disease which are rationally based upon the presumption of infection, etc., in so far as they interfere with freedom of the movements of persons and of merchandise, yet we see such action at an English port and the advocacy of such precautions when a ship arrives from an infected locality with suspicious cases on board as clearly indicate an opinion entertained by the local health authorities that at least the immediate locality and possibly also the general public are seriously threatened with an invasion of an infectious disease which could, under favorable conditions, develop into an epidemic. Whatever may be the real opinion of certain sanitary officials of high rank and of close relations with those who determine the policy of the government in such matters, it is very certain that the great mass of the medical men of Great Britain hold firmly to the belief that cholera asiatica is not only highly infectious, but is also transportable through the movements of persons and their soiled effects. Furthermore, if there be any country in the world which can safely rely exclusively or even in the main upon the good general and local hygiene and the efficient organization of local hygienic establishments for safety from a threatened invasion of epidemic cholera, that country assuredly is England, with her fortunate insular geographical position and her inland and maritime towns made comparatively clean by the judicious expenditure, within the last dozen years, of several hundreds of millions of dollars. It should be remarked that when the danger of invasion is thought to be imminent even the health authorities of this country appear to lack the courage to assume the risk of abandoning the effort to prevent the infection from effecting an entrance within the frontier lines.

I have had occasion already to mention the fact that the local authorities of the garrison town of Gibraltar, when that fortress was threatened with a visitation of cholera from the main land of Spain during the recent epidemic in that kingdom, established a quarantine for her protection. In this connection it might be well to refer to the fact that quarantines are by no means unknown on the island of Malta. Furthermore, I shall have occasion to show, whilst discussing the state of affairs in British India with reference to cholera, that whilst the general policy of the East Indian government in relation with the rest of the world as to cholera has been for some years against the admission of the contagiousness or transportability of the disease, and in this have been backed up by the highest sanitary officers of that government, not only is the great body of the medical profession in that country strongly convinced of the contrary, but even the general orders for the sanitary management of East Indian troops during prevalence of cholera, the essential infectious nature of the disease, and its transportability by the movements of men is distinctly acknowledged.



## SECTION 6.

## CHOLERA IN GERMANY.

## CONSULAR REPORTS CONCERNING CHOLERA IN GERMANY.

## CHOLERA AT FINTHEN AND GONSENHEIM.

The United States commercial agent at Mayence sent to the Department of State the following dispatches relating to cholera near Mayence:

This city and neighborhood have been somewhat alarmed during the present week by reports of the appearance of cholera in our midst, but investigation has dispelled these fears, and it is officially declared that the alleged Asiatic cholera is simply *cholera nostras*.

Three days ago, on the 26th, the report was widely circulated that in Finthen and Gonsenheim, two small places just outside Mayence, a sort of cholera had broken out, of which five or six persons had died, and that on the next day the authorities were sufficiently disturbed by the disease to take measures for the isolation of the affected. The furniture manufacturing establishments here had furloughed their workmen from the infected villages, and the soldiers of the garrison here were forbidden to approach these villages, which were undergoing a thorough disinfection. This intelligence was not only discouraging, but alarming, and in view of the seriousness of the matter, an expert was immediately called from Wiesbaden. Two of the leading physicians of Mayence visited Finthen and Gonsenheim and made a careful inquiry into all the facts and circumstances connected with the disorder which had appeared, as well as made a *post mortem* examination of the body of the last victim; and the result is that the malady is declared to be *cholera nostras*, and not cholera Asiatica, and all isolation, disinfection, etc., has been abandoned.

According to the published statements of the officials here there have been in Gonsenheim, from the 1st to the 13th of October, a number of cases of diarrhœa attended with vomiting, of which five ended fatally and none of which were infectious. And since the 14th of October, that is two weeks, neither a case of illness of the kind nor any death with symptoms of cholera. The victims who died were two old women, upwards of seventy years of age, and two other women of forty years of age who had been ill half a year, and a boy eleven years old. In Finthen, a woman who had been suffering with chronic diarrhœa for half a year died, and her nurse, a Catholic sister, took sick with a similar complaint on October 23, and died four days afterward, whose death the sanitary officers have particularly investigated, and made a *post mortem* examination of her body, and declared her death to be due to acute catarrh of the stomach and bowels, fat about the heart, and blood poisoning, and certainly not cholera; and no other cases have appeared.

From the commercial agency at Mayence, November 12, 1886, is the following:

Referring to my dispatch of the 29th ultimo, in reference to reported appearance of cholera at Mayence, I have the honor to inform you that since the date on which it was written but one further case of the disease treated of has appeared—that of a woman, who is again well. The malady was simply a few cases of *cholera nostras*, to which the press gave the form of cholera agres. The sanitary condition of Mayence and vicinity is good. For the information of the medical profession of the United States I think I should mention that it is officially stated that a further examination of the body of the nurse referred to in my dispatch revealed the presence of the so-called cholera bacilli, showing that they are not confined to Asiatic cholera only.

Mayence, November 16, 1886.—Referring to dispatches of the 29th ultimo and 12th instant, in reference to the reported cholera in this neighborhood, I have the honor to inform you that the Imperial Health Office at Berlin, which is, of course, the highest authority on the question, in its official gazette for November 9, makes a statement concerning the malady which appeared in this vicinity, which expressed in English is as follows: "In two places near Mayence, Gon-

senheim (3,356 inhabitants), and Finthen (2,374 inhabitants), a number of persons took sick and died during September and October under very suspicious symptoms. Particular inquiries at these places, in which the Government counselor, Dr. Gaffky participated, and a member of the Imperial Health Office, who was sent thither for the purpose, show that the first suspicious case at Gonsenheim appeared on the 17th of September (death occurring on September 20), and the last on October 13 (death taking place on October 14). The number of cases of illness which occurred amounted to 8, of which 6, after one to four days sickness, terminated fatally. The ages of those who died were 52, 72, 68,  $11\frac{1}{2}$ , 40, and 43. Of those who recovered, 35 to 45 respectively. The disease struck down in three families, one after the other, a son and a mother. In one family, first the wife and then her husband. Two of the affected families were separated from each other by only a few houses.

"In Finthen, half an hour distant from Gonsenheim, 9 suspicious cases have been learned of, of which 8, after one to five days' illness, proved fatal. The first suspicious case occurred on September 25 (death ensuing on September 26), and the last on October 24 (death ensuing on October 26). The ages of the deceased persons were 19, 37, 31,  $4\frac{1}{2}$ , 55,  $2\frac{1}{2}$ , 39, and 58, respectively. The individual who recovered was 64 years old. Hitherto it has been established that the victims came into contact with one another in some cases. The last case was that of a Catholic sister who had nursed the sick with great zeal. In the intestines of her corpse examined on October 27, death having taken place on the 26th, the presence of cholera bacilli was established. In what way the germ of the disease crept in from the infected parts, investigation has failed to show."

As soon as the authorities learned of the cases, they at once took measures to suppress the disease. Since October 14 no further suspected case of illness has been brought to notice in Gonsenheim; and since October 26, the date of the last death, there has been but a case of diarrhoea observed, which is said to have been brought about by an immoderate use of fruit. As a precaution the sick person was isolated, and was on November 2 already convalescing.

In communicating the foregoing I have further to say that I was at the office of Vital Statistics here to-day, and that the registrar assured me that no further suspected case of cholera had been noticed in that neighborhood, except at Castel, the place of writing, opposite Mayence, a soldier of the garrison there had been taken sick on last Saturday with vomiting and purging and cramps in the legs. By way of precaution he had been isolated, but that he is now convalescent. With the close of October, therefore, the malady entirely ceased.

The Berlin statement makes the number of deaths larger than was officially announced here, as will be seen by comparing the present dispatch with my former ones.

What the malady really was is an open question.\* According to Koch's theory, as cholera bacilli were found, we supposed the disease had to be regarded as Asiatic cholera; but the authorities here deny that there has been any cholera of the kind here, and say that the Koch theory is a controverted one. Two points, therefore, have to be kept in mind in viewing this matter: first, that the authorities here, in view of the commercial interests of Mayence, which would be materially injured by the establishment of cholera in this neighborhood, would naturally look at this disorder with as favorable an opinion as possible; and that, second, the Berlin people, governed by the Koch theory, would be disposed to pronounce it Asiatic cholera. On that account Mayence is in full communication with all parts.

Mayence, November 23, 1886, the commercial agent transmits to the Department of State the statement of the Grand Ducal Hessian Government concerning the suspected cholera, published officially by that government in the Darmstadt Gazette, its official organ:

"Of the cases of supposed cholera which occurred in the months of September and October at Gonsenheim and Finthen only the two last cases, as is known, came to notice of the authorities before death or recovery ensued. So that only in these two instances could microscopical and bacteriological examinations of the contents of the bowels of the victims take place. As has already been mentioned, the presence of Koch's cholera bacilli were found

\*There can now be no reasonable doubt that the disease at these points was genuine Asiatic cholera. This was the first instance where the nature of an epidemic was recognized by the presence of the comma bacilli of Koch.



in the remains of the nurse who died at Finthen on October 26; and they were also found in the evacuations of the woman who was last taken sick at Finthen, who is now well. If, as is to be concluded from the present state of scientific knowledge, the Koch cholera bacilli are to be met with only in Asiatic cholera, then it must be accepted that in both these cases real Asiatic cholera was at hand, and that this disease was also the cause of the other cases of illness which could not be subjected to a closer examination. However, as is known, since the 14th and 28th, respectively, of the past month, no case of illness in the place mentioned, nor in a wide circuit has appeared with the closest watching of the people, of a character to cause suspicion. It can not with foundation be apprehended that further cases of illness with like symptoms to those which occurred at Gonsenheim and Finthen can arise in connection with them. In view of the comparatively small number of cases of illness, and prompt and comprehensive disinfection of the places where the disease was, the Grand Ducal Government, in agreement with a member of the Imperial Sanitary Office sent by the Imperial Department of the Interior to the scene of trouble, did not hold limitation or stoppage of intercourse with them as called for, and opposed wishes and efforts loudly expressed in certain quarters therefor. In what way the cases of illness could have been brought about by infection from abroad, the most exhaustive inquiries have failed to disclose. Every supposition expressed in this connection has proved on close investigation to be only conjecture, and is not even found to be a probability."

The commercial agent at Mayence, January 8, 1887, forwarded a copy of a note from the Hessian Minister of State in reply to a note of the agent asking for certain particulars regarding the disease near Mayence. This note runs as follows:

"MINISTRY OF STATE, *Darmstadt*, December 31, 1886.

"SIR: I have the honor, in reply to your esteemed note of the 17th instant, to herewith communicate to you in what follows the information desired by you in reference to the cases of illness at Gonsenheim and Finthen, near Mayence, resembling cholera, given in accordance with the interrogatories put by you:

"(1) In the cases of diarrhoea accompanied with vomiting, and which appeared in the communes of Gonsenheim and Finthen, near Mayence, in the months of September and October of this year, regarded by the physicians in attendance as cases of native cholera, and first brought to official notice in the second half of the month of October, it was possible in but one instance of post-mortem examination of a dead body, and once in a case ending in convalescence to prove microscopically and bacteriologically the presence of Koch's bacilli in the contents of the intestines and in the excrement. The medical authorities are now ready to say, at least as regards the majority of cases which occurred, that it was Asiatic cholera, because, as the additional testimony showed, cases of illness appeared in very surprising numbers, considering the time, and relatively very high mortality occurred. And further, the connection of certain cases with one another and the communication from person to person by intercourse was demonstrable.

"(2) In what way the cholera germ slipped into Gonsenheim, the place first of all infected, has not been ascertained. The conjecture that it had been introduced by persons or objects from countries affected with cholera (Italy or Hungary) has, after an exhaustive examination, met with no confirmation. The transportation of the malady to Finthen and its spread in the two places affected was brought about through contact with the sick, but in several cases the manner in which the infection happened could not be established.

"(3) As already observed, since the suspicious cases of illness first came late to official knowledge, and the post-mortem examination of the 27th of October of the last of the victims did not in itself justify the diagnosis of Asiatic cholera, the result of the microscopical and bacteriological investigation of the intestines alone can be taken as reliable. By this means the presence of Koch's bacilli was established by various experts on the 29th of October and on the following day. In the present state of scientific knowledge the diagnosis of Asiatic cholera must be recognized as justified. As above mentioned, on the 29th of October, in the case of a person sick in the lightest manner and simply with diarrhoea, the presence of Koch's bacilli in the evacuations was established.

“(4) In Gonsenheim, during the time from September 17 to October 13, there were 9 persons of the age of 11, 30, 35, 43, 52, 58, 60, and 72 taken sick with symptoms of diarrhœa, combined with vomiting, of which 6 died. In Finthen, from September 25 to October 27, there were 10 persons who took sick, aged 2, 4, 19, 28, 31, 37, 55, 58, and 64, respectively, of whom 8 died; in all of which cases the least suspected are reckoned, but very light cases hardly came to medical notice. The duration of the sickness varied. In a few cases with a rapid course ending fatally, the symptoms lasted only 7 to 12 hours on the average. The length of sickness was  $1\frac{1}{2}$  to 2 days.

“(5 and 6) The victims did not belong principally to the poor population. Persons of medium means as well as those well-to-do were attacked. In several cases those affected were already sick with another complaint, such as phthisis, or chronic catarrh of the stomach and bowels, or were habitual drunkards, or people of irregular lives. With the latter the disease, as a rule, had a fatal course.

## SECTION 7.

### CHOLERA IN AUSTRIA.

*CONSULAR REPORTS RELATING TO CHOLERA IN TRIESTE, BUDA-PESTH, AND VIENNA, IN 1886.*

#### TRIESTE.

In a dispatch from Trieste, of July 5, 1886, the consul reports: “From June 7th to 29th, inclusive, there were 6 scattering cases of cholera, followed by death. These few cases occurring at intervals would cause no alarm were it not that we are surrounded by cholera. The city of Venice, only 6 hours by sea and 7 by land, has suffered greatly therefrom.

The malady has appeared at Udine, a short distance across the frontier in Italy, four hours distant by rail. At Fiume, about the same distance by rail, the illness has also appeared with fatal effect.

All the cases in this city proved fatal. Among these 6 victims were people of all classes—3 of laboring men, 2 women living with comfortable surroundings, and 1 gentleman of wealth.

The sanitary authorities are very vigilant; all suspected cases are immediately removed to the cholera hospital. Daily visits are made to houses for inspection of sinks, etc. The streets are kept very clean; the houses from which patients have been removed are disinfected and placed in quarantine, no person being allowed to enter or leave the premises.

The generally expressed opinion of the medical authorities is that during the month of August the malady will increase.

All bills of health given at this consulate to vessels clearing for the United States have noted upon them the date and number of cases since June 7th.

In a dispatch from Trieste, of September 1st, 1886, the consul reports the total number of cases in Trieste from August 1st to 31st, inclusive, to be 290—deaths, 198; and in Fiume, during the same period, the total number of cases was 65, and of deaths, 37.

Reference is made to the official table embraced in a former dispatch which gives for Trieste 108 cases, 60 deaths; for Fiume, 135, 73 deaths (for the month of July).

It will be seen that in the city of Trieste there has been an increase of 182 cases and 38 deaths over the month of July. The epidemic in Fiume now appears to be decreasing; and the number of cases in Trieste proper is also at present comparatively small; but in several of the mountain hamlets, immediately above the city, which have not yet been put in a clean condition, the disease makes greater inroads.

About 100 cases have occurred in this consular district outside the city of Trieste and Fiume.

Of the many persons employed in ministering to the wants of the cholera patients, such as doctors, nurses, transporters of the sick and dead, not one death has occurred; neither have any of these attendants been affected with the illness.



Houses in which several cases have occurred are closed, and will remain so until the epidemic is deemed over. As most persons thus far affected with the malady are of the poorer classes, they and their effects are removed by the medical authorities to other buildings, and they are under the vigorous surveillance of the cholera authorities. The school buildings will not be opened for school purposes until the epidemic has entirely disappeared.

In a dispatch from Trieste of October 4, 1886, the consul reports the following cholera statistics: For the month of September, 245 cases, 157 deaths in Trieste; 70 cases, and 51 deaths in Fiume. By reference to the last dispatch it will be seen that in Spitz there have been 45 cases, 41 deaths less in the city of Trieste from cholera than during the month of August; whilst in the city of Fiume there was an increase of 5 cases and 14 deaths over the preceding month.

During the past three months no cases of diarrhœa, or other disorders of the bowels, have been reported, all such illness being classified as cholera. Many infants and young children have been attacked.

In almost all cases of choleraic attacks the patients have been of the poorer classes who, during the present depressed state of trade and industry, find it difficult to find employment, and, consequently, are unable to earn sufficient to provide themselves with wholesome food, in the absence of which they subsisted chiefly on fresh fruits, such as figs, peaches, plums, etc., which are here obtainable at very low prices.

The total number of cases in Trieste since the cholera epidemic began is 649, and the total number of deaths 421.

In another dispatch from Trieste, the consul reports that since November 6th there have been no cases of Asiatic cholera in the city of Trieste and Fiume, and that the epidemic is declared to have ended, and that vessels are now permitted to leave these ports with clean bills of health.

The extent of the epidemic, from the time of its appearance, June 6th, to its disappearance, November 6th, is reported as follows: In Trieste there were 550 deaths out of 896 cases. In Fiume there were 161 deaths and 260 cases.

#### BUDA-PESTH.

A dispatch from the consul-general at Vienna, September 16, 1886, relating to the cholera in Buda-Pesth, reads as follows:

Confirming my cable dispatch of to-day, I have the honor to transmit herewith a copy of a letter from United States vice-consul at Buda-Pesth, informing this consulate-general, under date of the 15th instant, of the appearance of cholera in that city.

Newspaper dispatches from Hungary published in this morning's issues, contend that the city physician of Buda-Pesth, as well as the sanitary inspector, have up to date discovered no cases of Asiatic cholera; but only "*cholera nostras*." The authorities of Vienna, however, seem to have little confidence in these official representations, and have at once called an extra session of the sanitary council of the empire for the purpose of guarding against the conveyance of the infection.

The line of steamers now running between Trieste and New York form the only direct line of communication and travel between Austro-Hungary and the United States. All possible precaution in this direction would seem to be imperatively necessary.

In the above-mentioned copy of the letter from the vice-consul at Buda-Pesth, it is stated that 3 cases of cholera, 1 of *cholera nostras*, and 6 of cholera, of which latter 1 case ended fatally, have been reported to-day, September 15th, and also that from September 12th to the 15th over 3 cases of cholera were registered, of which 11 were fatal.

In a dispatch from Vienna of October 19, 1885, the consul-general writes:

Confirming my cable dispatch of the 18th instant, I have the honor to report that the first case of 'Asiatic cholera' occurred in Vienna on the 18th instant, and that the result was fatal, the patient dying within 18 hours after the first symptoms were discovered. The victim however, was not a resident of Vienna, but a citizen of Buda-Pesth, and a prominent officer of the Austro-Hungarian State railroad. He arrived here by rail from the latter city, and was taken sick almost immediately after his arrival, and there can, therefore, be no manner of

doubt that he contracted the disease in Buda-Pesth. This fact is the source of great consolation to the Viennese, and the hope is expressed by the authorities that the case in question will be the last to occur in this city, at least during the fall and winter. For the last three months the epidemic has given rise to serious apprehensions in Buda-Pesth, because it has constantly increased, and has been of a very violent character, more than 50 per cent. of the persons attacked dying of the disease, and still railroad travel between Vienna and Buda-Pesth has been entirely uninterrupted, and no supervision or examination with reference to arrivals from Buda-Pesth has so far been organized on the part of the municipal authorities of this city. Now that the mischief is done, possibly more energetic action may be expected. At any rate, the authorities are quite energetic enough to eradicate, if such a thing is possible, all traces of the cholera bacillus which the dead man may have left at the hotel where he breathed his last. The hotel has been closed, and the bed and bedding of the victim, and all his wearing apparel have been burned and 400 pounds of carbolic acid have been used to disinfect the infected premises. I take the liberty to point to this want of timely precautionary measures, because I am decidedly of the opinion that this sort of malfeasance increases the danger of the conveyance of the epidemic to the United States. It is not to be supposed that the authorities at Fiume and Trieste, from which ports it is probable that especially the poorer classes of Hungarians would embark for the United States, will exercise greater care and inaugurate more efficient means of precaution than the great city of Vienna has seen fit to employ."

From the consulate-general at Berlin, dated September 17, 1886, the Department was apprised by cablegram of several deaths announced in Buda-Pesth as having occurred from *cholera nostras* during the last two days.

A dispatch from the consulate at Breslau, November 20, 1886, relating to cholera and emigrants, states that only 1 case of cholera existed in Silesia up to date; and speaks also of restrictions now placed on emigrants in Breslau, and also upon pauper emigration at the Austrian frontier, which have been removed for some days.

From the consulate at Buda-Pesth, in the dispatch dated October 12, 1886, concerning cholera in Hungary, the following is related: The first authentic case of cholera was observed on the 7th of September in a woman who was taken ill and soon died of the disease. The cholera became epidemic on the 12th of last month, when 10 persons were seized with *cholera nostras* and with Asiatic cholera. Since that time the cases of cholera continually increased up to the 21st of last month, attaining a daily number of 50, out of which 18 to 20 were fatal. It is to be observed at the same time that the persons attacked were confined almost exclusively to the lower class. The municipality adopted all necessary preventive measures; scrupulous control is practiced as to disinfection, drinking water is boiled, and separate stations are established where boiled drinking water is served. The lower schools are closed, and separate hospitals erected for cholera patients especially. Committees were constituted in the different districts in the city. The members of these committees strictly attended to the disinfection of the houses and streets, and took great care that such houses where cases of cholera occurred be immediately and radically disinfected. Owing to these measures, as well as to the mild character of the disease, the cases of cholera continually and regularly lessened ever since the 25th of last month; so that at present the number of cases reported has sunk to about 15 per day. According to official statements the total number of cholera subjects in Buda-Pesth amounted, up to the present, to 663, out of which 233 were fatal. As to the Provinces I have the honor to report that, with the exception of the town of Fiume, cholera occurred but very sporadically; while in most cases it is even doubtful whether it is real cholera or some gastric disease. At Gyor this disease appeared for a time in some epidemic manner, as in Buda-Pesth, but lost its character within a few days, and for a considerable time no case of cholera has been reported. Cholera has taken the most dangerous and acute character in Szeged, one of the principal towns of Lower Hungary, with 60,000 inhabitants, where at present 30 to 40 cases occur daily with an increase whereby almost three-fourths of the sick are dying, while the average of deaths to cases in Buda-Pesth is hardly one-third.



## SECTION 8.

## CHOLERA IN SOUTH AMERICA.

*CHOLERA ON THE STEAM-SHIP MATTEO BRUZZO, BETWEEN GENOA AND MONTEVIDEO, 1884.*

Koch gives the following very significant account of this ship's epidemic : \*

A very noteworthy and in many respects instructive case, as it appears to me, of ship's cholera occurred during the last epidemic (1884). It was furnished by the steam-ship *Matteo Bruzzo*, which sailed from Genoa for Montevideo with Italian emigrants. I have to thank Professor Cecci of Genoa for an account of this ship's epidemic, from which I abstracted the following : Upon the ship were 1,333 souls, 1,244 of whom were emigrants, the majority being from the Northern, then the part of Italy most invaded by cholera. The disease had already broken out in Genoa and a notice of the fact was entered in the ship's papers by the consul. On the 3d of October the *Matteo Bruzzo* left the port of Genoa. On the 8th of October, while the ship was passing Gibraltar, according to the ship's log, a boy of fourteen years of age died of *aneima*; on the 16th of October a child six months old died of *cramps*; on the 14th of October a child eleven months old died of *pronounced digestive troubles*, as the log says; on the 25th of October a woman died of *colic*; this death was shortly afterwards followed by two others *not specified*. On the 28th of October the ship arrived at Montevideo. It was, however, on account of its unclean bill of health forbidden to land. It remained in the roads of Montevideo, because the captain hoped that later landing would be allowed, or that at least the emigrants would be taken off or allowed to pass through quarantine. But this hope was not realized. He was forbidden to land under any circumstances. Whilst the *Matteo Bruzzo* was riding in the roads of Montevideo on the 7th of November three fatal cases occurred, and they were now registered in the log as *cholera*. From that it would seem that the cholera first broke out on the thirty-first day of the voyage; after that, cholera cases followed each other rapidly, viz, on the 8th, 9th, and 10th of November. The captain could, under these circumstances, no longer conceal the presence of cholera on board, and he finally declared to the authorities the condition of his ship. Thereupon he was directed to proceed to the port of Rio de Janeiro and remain at the island of Ensenada las Palmas. This island is a quarantine station for Rio de Janeiro, about a half day's sail from that port; but the captain of the *Matteo Bruzzo* did not appear to have known the exact position of the island, for he sailed directly for the port of Rio de Janeiro. The authorities there had been warned from Montevideo, for, as the *Matteo Bruzzo* sought to enter the harbor a shot from Fort Santa Cruz was fired directly across the bows of the ship, a second went way ahead, and a third went through the rigging. This cooled the courage of the captain somewhat, and he stopped. Then a boat came off with instructions that he leave the harbor at once and go to the island of Ensenada. There was nothing for him to do but to obey. At the island the *Matteo Bruzzo* was met by a couple of men-of-war who took her in charge. She was allowed, under strict surveillance, to take provisions and coal aboard in the roads, and was afterwards escorted to sea by the two war-ships. The *Matteo Bruzzo* then sailed upon her return voyage to Genoa, where she arrived on the 19th of December after having passed through quarantine at San Stefano.

This is the sorrowful story of the *Matteo Bruzzo*. That ship had, therefore, during the whole voyage no direct communication with land. It is stated that the cholera first broke out on the thirty-first day, and the last fatal case on board ship was registered in the ship's log on the 23d; that is, on the 52d day of the voyage. As far as I know there is only one ship, the *Apollo*, upon which in 1849 cholera lasted longer; she had cholera aboard fifty-six days. Altogether there occurred on board the *Matteo Bruzzo* 40 cases of cholera, 20 of which were fatal, viz, 19 passengers and 1 of the crew.

This ship's epidemic, like so many others, shows how little reliance can be placed upon ship's officers and ship's surgeons. Personal interest almost always outweighs a disposition to

\* Conferenz zur Erörterung der Cholerafrage. Berlin, 1885.

avow a truth which might bring, as a consequence, troublesome quarantine regulations, or unpleasantness of other kinds, and the endeavor is made to conceal the outbreak of the contagious disease entirely, or at least as long as it is possible. I am convinced that in the case before us cholera did not first break out on the 7th of November, but that almost all the fatal cases from the departure of the steamer until its arrival in Montevideo were cases of cholera.

We will now refer to a few cases of ship's cholera which serve to prove how little faith we should accord to the records of ships' epidemics, and which show that the ship's log usually only records a fractional part of the truth.

A very pregnant example of such a case is mentioned in the Transactions of the International Sanitary Conference of Constantinople.

There arrived on the 28th of June, 1865, at Constantinople, a frigate five days out from Alexandria, which was then invaded by the cholera. Upon arrival, it was declared that all on board were well, consequently the ship was allowed pratique, but among the persons landed twelve suffering with cholera were at once discovered, of which one died the same night. When the matter came to be further investigated, it was admitted that two cholera corpses had been thrown overboard at sea.

I myself have seen something similar during my sojourn at Tor in November of 1883. Soon after my arrival at Tor, two ships came from Jeddah, each of which had on board about 500 pilgrims returning home from Mecca. In this case, also, the surgeons of both ships declared that the state of health was excellent, that no cholera was on board, and that during the voyage only a few pilgrims had died from *senile debility*. On the next day I myself was present at the landing of the first pilgrim ship and became convinced that a number of the pilgrims were strikingly weak and ill. Scarcely were they on shore before many sought the latrines, and a glance at their evacuations showed at once that they were suffering from dysentery. Moreover, there were several pilgrims who were so weak that they could scarcely stand. One of these by his sorrowful countenance especially attracted my attention. While he was being examined, through the assistance of an interpreter, he stated that for about two days he had been suffering with vomiting and diarrhoea. This patient was placed in the lazaretto, where he took to vomiting and purging and exhibited all the other symptoms of cholera and died the next day. Not only was this a case of cholera, but there appeared among the pilgrims of both ships a number of attacks of cholera during their quarantine at Tor.

A further example is offered by an English merchant ship, the *Acomac*. This ship sailed from Bassein on the 28th of February, 1884, and arrived at Suez March 24, where the usual visitation was performed by the quarantine physician. I place before you an exact copy of the interrogatory. The captain stated that he, with 28 men, departed from Bassein, and that during his voyage there had occurred no disease among his crew; thereupon he was granted free pratique through the Suez Canal and the ship subsequently sailed for Genoa, its port of destination. There it became evident that the captain whilst at Suez had declared an untruth, for a few days after the departure from Bassein 4 attacks of cholera took place aboard, 2 of them with fatal results. Now, it is not very clear to me how the captain was able to make the strength of his crew, decreased by two, correspond with the ship's papers.

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*THE CHOLERA ABOARD THE STEAMER "PLATA" BETWEEN NAPLES AND RIO JANEIRO, 1886.\**

The morning of the 21st of December, 1886, the steamship *Plata* of the General Italian Navigation Company cleared from the port of Naples (but she remained two days in the harbor after having taken her passengers aboard, on account of bad weather). There were aboard 48 members of the crew and 874 passengers, which latter, for the most part, belonged to families of the provinces in the south of Italy, and were emigrating to South America. They were in poor circumstances, and there were among them a large number of pregnant women, and about 150 children, from a few days to 5 years of age. The sea was calm, but in the night it became rough. On the following day and night the ship was much tossed about

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\* Dr. Francesco la Rotonda.



by the waves; rain fell continuously, and the wintry weather was so cold that the kind-hearted commander, Marcello Rosasco, of Genoa, thought it prudent to drop anchor in the Gulf of Palma, at the south of Sardinia, in order to give a little rest from the sufferings of the passengers.

The night of the 23d, the ship's surgeon was called to the assistance of a child of 5 months, whom he found in the agony of death, and who died shortly of diphtheria. He endeavored to isolate the children who occupied the same cabin, but it was impossible on account of the limited quarters of the steamer. Instead of isolation, he limited himself to the most thorough cleanliness and to the use of large quantities of disinfectants (chloride of lime, carbolic acid, and fumigations of sulphurous acid). Nevertheless 42 children took the disease, of which 5 died; some experienced secondary troubles, and one suffered from anorexia, which required special treatment for twenty-four days. The treatment in general consisted in applying to the diphtheritic patches, as soon as they appeared upon the tonsils, carbolic acid and glycerine in the proportion of 1 to 3 besides laving with solutions of chlorate of potassa or boracic acid. This circumscribed epidemic lasted 21 days, so that on the 12th of January, in the neighborhood of the equator, with a temperature of 30 C., there were no longer any children affected with diphtheria. This good fortune was no doubt due principally to the construction of the ship, which was entirely of iron, not excepting the deck.

The steamer came to anchor on the 15th, and remained three days, at Grand Island on the southern coast of Brazil, near the lazaretto; she was then free from any infectious disease, and in excellent sanitary condition.

On the 18th of January she sailed for Rio de Janeiro, where she remained for 20 hours in the bay in order to take aboard coal, fresh provisions, and three beeves, and then set sail for Montevideo. In this latter city there were some cases of cholera. She halted there for 12 hours to discharge some merchandise, but without taking anything on board, and then directed her course for Buenos Ayres, which had then been infected with cholera for a month or more.

She cast anchor in the roads nine or ten miles from the city of Buenos Ayres, on the 24th of January at 9 a. m. On that day no one visited her from the land. On the 25th, the sanitary officer of the port came on board, but refused to give free *pratique* on that day; and other physicians acted in a similar manner on the 26th, and on the following days up to the 30th. This action was taken on account of an ungrounded suspicion of Dr. Ramirez, who thought that he had found a convalescent from yellow fever aboard, arriving at this assumption from the yellow color of the skin, but the patient was suffering from splenic leukæmia. He based this supposition solely upon the fact that we had come from Rio de Janeiro, but without having been in communication with the land. Our statements were ignored, as also the shortness of the time, 7 days, since we had left Rio de Janeiro, in which short period it would not have been possible that yellow fever could have run its course, as also ignoring the fact that yellow fever did not exist there, and the fact that the patient presented the characteristics of leukæmia. This stubbornness was probably based upon the indecision of the republican authorities, as to whether to hold us under observation or in quarantine on account of the large number of passengers for whom we were responsible. Meanwhile, these ignorant passengers committed errors of every kind. Among other imprudences the poor people, in order to quench the thirst which they suffered between the tropics, drank the water of the river Rio de la Plata, which, in irony, has been named a "river of silver," for, in fact, the turbid water is of a dirty red. During this dangerous period, the experienced commander, Captain Marcello Rosasco, presented a justifiable protest to the Italian minister resident there, but the latter took no action. Our situation became constantly more dangerous with such a large crowd of people aboard without the benefit of ventilation which is secured while under way, and who were in communication every day with Buenos Ayres, which was then infected with cholera, and from which provisions were daily received. Our fears were verified on the night of the 30th and 31st by the occurrence of the first case of cholera in a man of 54 years. This case was succeeded on the 31st by three others, and on that day was the first death of a man 31 years of age, and then on the following night two others were attacked, and one of the previous cases died.

After our energetic remonstrances the republican government, at last recognizing their error, on the 1st of February ordered a small steamer to remove the two corpses and to take off the sick and another to remove the passengers. All were transported to a small island, Martin Gracia, where the lazaretto was located, at the northeast of the gulf. There the epidemic continued for some days, making victims of more than 70 of the passengers. Among the crew left on board we had to deplore the death of only one sailor 35 years of age, who had acted as a nurse to the sick, and who had also taken much rum and other liquors to such an extent, indeed, as to become greatly intoxicated. He was attacked on the 2d of February, and died the next day.

From this circumscribed and characteristic epidemic which we had abroad, I was able to collect the following facts, which simply confirm what has already been established concerning the disease.

(1) The cholera virus is not diffusive to such an extent that it may be inhaled with the respirations like the malarial miasm, and the infection cannot be communicated by currents of air.

(2) The period of incubation did not surpass five days, judging from the length of our indirect communication by means of the food.

(3) The cholera germ was received from Buenos Ayres, adhering to vessels, baskets, bags, and boxes, in which the food was brought to us, and which remained aboard among the passengers for 24 hours. It was not conveyed by means of vegetables, fruit, cheese, meat, tobacco, soap, etc., and there was no direct contagion from person to person.

(4) The cholera was brought to us from the above mentioned locality, for none of the passengers or crew were from any infected port or city, and in the 42 days of our voyage there was no sign of suspicious disease aboard, nor was there any communication with infected places.

This implantation from Buenos Ayres caused the epidemic among the passengers, who were already predisposed to it by the long and troublesome voyage, with the sea always rough, to which they were unaccustomed and which caused most of them to suffer from sea sickness. Their mental condition, the fear of not being at once landed, and the excitement occasioned by their arrival at a strange place, were also conditions which interfered with their vital processes; and to these disturbing influences, the imprudence in diet which they constantly committed through ignorance are also to be added. Furthermore, filthy personal habits also played a part: most of them wore the same shirt and the same clothing with which they came aboard, because they had no others; all of them were covered with coal dust which came from the engines, and cutaneous perspiration, so necessary, especially in crossing the torrid zone, was interfered with by such carelessness.

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*CONSULAR REPORTS RELATING TO CHOLERA AT BUENOS AYRES IN 1886.*

In a dispatch from the consulate at Buenos Ayres, dated November 6, 1886, to the Department of State, the consul writes as follows: I have the honor to inform you that for several days past there have been reports of the appearance in this port, as also that of Rosario, of some disease resembling Asiatic cholera, both in its symptoms and fatality; and that, in consequence, there is now no little doubt that the Argentine Republic is to be visited with that epidemic. Thus far there have been seven deaths in Rosario, mostly of emigrants recently arrived in the Riachuelo port of this city. Probably as many more have occurred among the sailors of merchant vessels. The board of health of Buenos Ayres do not regard the deaths as having been the result of cholera, but of imprudence in eating unripe or decayed fruit; and a letter just received by me from the United States consul in Rosario says: "I do not think there has been any cholera except such cases as might occur at the beginning of the fruit and vegetable season." There is, however, a general feeling of apprehension, and quarantine has been declared against the Argentine Republic by both Uruguay and Brazil, thus very seriously interfering with the course of commerce and navigation. Until other developments, I think



it would be peremptory for me to refuse to give clean bills of health to vessels clearing for ports of the United States, but if the disease continues I shall deem it my duty to do so.

In a dispatch from the same consulate, of November 20, 1886, the consul states: Referring to my dispatch of the 6th instant, I have the honor to advise you that the disease which I mentioned as having made its appearance in this port has at length been officially pronounced to be Asiatic cholera. The number of cases since it appeared, about the first of this month until the present time, have, in all, only amounted to about forty, of which one-third have proved fatal. There is a general apprehension, however, that, with the approach of warm weather, the disease may take an epidemic form and exhibit a more malignant phase than it has as yet developed. Should this be the case, the city is not in a condition to resist its inroads. Meanwhile this port is entirely cut off by rigid quarantine from Uruguay, Paraguay, and Brazil; and I am informed that cablegrams of the most exaggerated character have gone to the United States and Europe in regard to the ravages of the disease here. Of course, under these circumstances, foreign commerce is quite suspended, and business in the interior of the Argentine Republic is at a stand-still. I now note on bills of health issued from this consulate that cholera exists in the port, but not in epidemic form.

In a dispatch from the same consul, November 27, 1886, an inclosure from the Buenos Ayres Standard of November 27 is found, from which the following abstract is taken:

"A month and a half has now elapsed since the first case of cholera occurred, and we are happy to say that, owing to the great precautions taken and the remarkable activity of the authorities, the disease has not assumed an epidemic form. Our most experienced physicians, who judge from the cases that have come under their notice, are of the opinion that the cholera that exists on the Platta is of a mild sporadic nature, and in nothing resembles the visitation of 1867 and 1868. In Rosario the disease seemed for a time to make greater headway than elsewhere, and for awhile the various contiguous provincial authorities stopped the trains, but the National Government very properly interfered, and now the trains run and communication with the interior is no longer interrupted."

December 6, 1886, is the date of a later dispatch from this consulate relating to cholera. It is as follows: Referring to my dispatches, I have the honor to inform you that while a few cases of cholera are still reported in each day's bulletin, the disease appears to have pretty much run its course at this port. On yesterday, up to 10 o'clock, only one new case had occurred in the city proper and two cases on board a steamer at the Boca port. In the interior of the country, however, the disease has made its appearance, and in some places with a very marked type. On the 4th instant there were 14 deaths at Rosario, 14 new cases, and at Gorboba 2 deaths and 5 new cases. In Tecumán there were 3 cases but no deaths, and isolated cases are reported about various other interior towns. The alarm, however, which was produced among the people when the disease first appeared at this port has in great part subsided, and the authorities feel assured that the prompt and rigid measures taken to stamp it out will prevent it from becoming epidemic. During the month of November, according to the *Revista Medical*, in this city, the figures are as follows:

Cholera cases in the city proper.....	63
Mercedes Hospital.....	83
Womans' Lunatic Asylum.....	29
Boca port.....	65
Elsewhere adjacent to city.....	17
Total number of cases reported.....	257

Of these, about 70 per cent. were fatal. These returns show an average of only about 8 cases per day during the months, which in a city of 400,000 souls, can certainly not be considered as alarming indeed. In the twelve years that I have been here I do not remember a summer which has not had a larger number of cases of diarrhoea or cholera morbus, and with equally fatal results. I make this statement in view of the grossly exaggerated reports which have been cabled to Europe and the United States from Montevideo in regard to the cholera at this port, and which have had the effect of closing nearly all the ports of the world to arrivals from Buenos Ayres. In this state of affairs all commercial business is at a stand-still, or nearly so.

In all bills of health now issued by me I note the fact that cholera exists in this port, but not in epidemic form. Otherwise the health of Buenos Ayres could not be more satisfactory than it has been during the last month.

The final dispatch relating to cholera from this consulate bears date February 5th, 1887, and is as follows:

Referring to my last dispatch in regard to the cholera epidemic in the Argentine Republic, I have the honor to inform you that the disease seems at last to have quite run its course. Day by day in all the centers of population in the country the number of new cases is becoming less, and there is now a feeling of relief that it will only be a short time before the ports of the world will once more be freely open to clearances from Buenos Ayres. Commerce and general trade are already feeling the impulse of the improved condition of the public health.

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LEGATION REPORTS RELATING TO CHOLERA IN BUENOS AYRES, 1880.

The United States minister to the Argentine Republic reports as follows, December 3, 1886, concerning cholera in that country:

There is no reason for doubt as to the existence of Asiatic cholera here. It made its appearance about five weeks ago, and was imported by the Italian ship *Perseo*, plying between Genoa and Buenos Ayres.

Don Antonio del Veso, envoy extraordinary and minister plenipotentiary of the Argentine Republic in Italy, was a passenger on the ship, and the anxiety to secure him an immediate landing, on the part of the ship's commander, seems to have so far overcome his sense of duty that, by concealed or garbled reports, he managed to turn loose, on Argentine soil, first here, then at Rosario, a great many persons from an infected ship. The testimony of passengers shows conclusively there was nearly a score of burials at sea of those who died of cholera on the voyage.

The Argentine Government instituted prompt investigation of the matter, but, wasting no time with the infliction of empty penalties which can not affect the disease, turned its entire care to its arrest and confinement within its present limits. Dr. Wilds, the minister of the interior, and as such prime minister of the Government, from whose department the national board of health derives all its powers and efficiency, is himself a physician of much distinction, and has labored with heroic devotion in the employment of every agency tending to the rapid and complete accomplishment of his sanitary measures. He has at his disposal money, physicians, and police powers almost without limit, and is employing them all with great spirit and ability.

The exercise of sanitary measures has been so prompt and efficient, and the use of disinfectants and enforced cleanliness so well spread and rational, we venture to hope the disease will disappear before assuming an epidemic character. The people, generally, fully sympathize with the good intentions of the Government, and, instead of interposing hindrances in the way of its sanitary plans, help them on in every possible way.

For the month of November just closed the official reports of the cholera hospital in Buenos Ayres show there were 200 patients entered—93 deaths, 34 cured, with 73 still under treatment. Remembering the population of Buenos Ayres is fully 400,000, you will agree the showing thus far is not discouraging. And with the exercise of a little scrutiny even the exhibit may be much relieved of alarm, for of the 200 patients above enumerated, 130 were from the male and female lunatic asylum and 12 from the prisons, where people are greatly huddled together and hygienic conditions anything but favorable. This then leaves but 58 cases outside for an entire month.

The greater part of the cases have originated in the 'Boca' where the infected ship *Perseo* landed, which is a scooped-out place, so deep and below the level of the river Platte that ships may enter and discharge. It is, therefore, necessarily a vast receptacle of filth, and, there being no current to carry out its accumulations into the river beyond the sluggish action of



the tide, it remains there a perpetual cesspool charged with disease and death. The Government, however, is already busy at work there with an immense force, devising means to sweeten its baleful waters by the use of powerful pumps and dredges.

The disease is most fatal at Rosario, a city of commercial importance, on the Pasaka River, 200 miles away, where the most of the *Perseo's* passengers and cargo were discharged. The reports from that locality are truly distressing. In a population of about 50,000 souls they are now having from 35 to 50 deaths per day. In their cholera hospital alone there were over 200 patients in November, of which more than one-half died; but there the disease has invaded the homes of the best and most prudent families of the city. Cordoba and other inland cities are also becoming infected.

The result of all this is, we are nearly cut out entirely from the commercial world. Uruguay, Brazil, Paraguay, and the most of the European ports are quarantined against us, which fact has greatly disturbed the movements of the mails and almost entirely suspended business. We have recently had some very cold weather, which has been favorable to us.

Nineteen years ago yesterday the first case of the great cholera epidemic of 1867-'68 was reported. Then the plague was mainly confined to the city and neighborhood of Buenos Ayres. It was very destructive, and did not die out until near the close of March, on the advent of winter.

Of course, we are still in a state of anxious suspense, for if the hygienic expedients now in a rapid course of development do not eradicate the dreaded microbes of the plague, the hot season already upon us, may plunge us into very serious distress. Business is virtually suspended in Buenos Ayres, and vast numbers of people have gone out into the country.

The United States minister, in his dispatch dated December 16, 1886, again writes as follows:

Referring to my dispatch of the 3d instant, I may add the cholera is on a steady increase here, and that it has assumed more deadly features. Thirty-six new cases were reported to the board of public assistance of Buenos Ayres yesterday, more than half of which died in a very few hours. The worst of all lies in the fact of its rapid spread throughout the inland provinces. This dreadful disease, 'which walketh at night and wasteth at noonday,' leaps the prudence of quarantine and breaks down every line of military cordon. It is still raging fiercely at Rosario, and has recently broken out at Cordoba, Tecumán, Zarati, Bahia, Blanco, and Azul, and, worse than that, has gained a foot-hold on the island of Martin Garcia, where 5,000 terrified immigrants are detained in quarantine, without sufficient food or shelter. We have great fears of appalling results there.

These fears are based on rumors, which are repeated to the Department as such. I have watched every movement of the Government carefully, and though there may have been mistakes, both by omission and commission, not above criticism, I can not discover any lacking on the part of the machinery of the Government to do actively and liberally all that seems best. The country, of course, is filled with terror, and at such a time very naturally the power of reason and the exercise of good judgment are not at their best.

Touching the cholera in Argentine Republic, the United States minister at Lima, in his dispatch of the 29th December, 1886, thus advises the Department of State:

Great precautions are being taken in both Chili and Peru against admission of the dread disease from the Argentine Republic. All ships touching at ports on the South Atlantic side are prohibited entrance to the ports of Chili and Peru. The mountain passes in the Cordilleras are being guarded to prevent all passage and there is much concern felt here as well as in Chili. So much so that insufficient causes might at any time induce very inconvenient regulations in Peru against steamers from the south.

The United States consul at Buenos Ayres, as late as January 7, 1887, states that "cholera still exists in this city, but that it makes but little progress in assuming an epidemic form. The average number of cases per day since my last dispatch (December 6) has not exceeded 22. The greatest number of reported cases in one day occurred on the 30th ultimo, when the number reached 57, since which time it has steadily declined, and on yesterday the number was only 11 in the city, with its population of 400,000 souls." He incloses a clipping from the Buenos Ayres Standard, from which it is learned that during the months of

November and December there were 871 cases of cholera, and 474 deaths from that disease. The consul also states that "the disease has scarcely made its appearance except in closely packed tenement-houses (conventillos) of the lower classes and in the suburbs, which are without pipe and hydrant water. In the interior of the Argentine Republic, however, the disease has assumed the proportions of an epidemic. In Rosario, during the last month, the daily number of cases averaged 60 to 100, while about 70 per cent. were fatal. In Mendoza the development of the disease has been most remarkable, and the population of that city of 20,000 has been almost decimated; and in the country districts the disease was equally fatal. In Tecumán the number of cases has on some days been as high as 500, of which about one-half proved fatal. Indeed, the panic at one time was so great that it was not possible to obtain the requisite assistance to bury the dead. In nearly all the other interior cities the disease has been very virulent and fatal, but, not confining itself to centers of population, it has ravaged entire provinces, and farmers (estancieros) and camp men have in great numbers succumbed to it. I am happy to say that with medical assistance, disinfectants, medicines, and a large supply of good nurses, the disease seems to have greatly abated during the last two weeks, and the hope is entertained that it will soon have run its course."

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*THE MEDICAL PRESS UPON THE CHOLERA IN THE ARGENTINE REPUBLIC.*

CHOLERA IN BUENOS AYRES.\*

Cablegrams which are repeated daily have announced since the beginning of last month the appearance of cholera in the beautiful city of the Plata and in other neighboring cities—Rosario—and the number of cases and deaths has increased day by day.

At the beginning it was thought that the cases were nothing more than choleriform, so frequent during that season. But, in view of the increasing number of the cases and deaths occurring, and of a close study of the character of the disease, they have been convinced of the presence of the terrible visitor. It was at that time desolating some localities in Italy, Austria, and Hungary, after the ravages it had committed in Spain last year.

How did the disease appear on the banks of the Plata? Did it spring into life there spontaneously, or was it imported? In the latter case why did it not first appear in Brazil, whose ports are visited by travelers from Europe before Buenos Ayres is reached? These are questions which we put at present, but can not answer.

All that we know at this moment is that the place chosen for the first appearance of the disease has been the insane asylum, which, very probably by its hygienic conditions, offered the most favorable circumstances for the development of the germs. It is known also for the infected places that its invading march is more toward the interior than toward the sea.

In the same journal (No. 15, January 1, 1887), whilst discussing the cholera on the Plata, the editor remarks as follows:

The second focus was formed in a few days afterwards in the insane asylum, called Mercedes, which is the institution that has furnished the most combustible material to the epidemic.

An inmate escaped from this asylum and was found in La Boca, and was undoubtedly the carrier of the contagion.

A circumstance causes the belief, however, that the importation came from the San Roque Hospital. In the Mercedes Asylum the clothing from all the other hospitals is washed; thus it is that the origin of the cholera among the insane is attributed to the carriers of the cholera patients who died in said (San Roque) hospital, but later testimony proves that the clothing of that deceased had been burned in San Roque Hospital.

The two foci of the epidemic being established, it spread more and more each day without hindrance other than that which a well organized and energetically executed system of defense opposed.

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\* From *El Monitor Médico*, No. 13, December 1, 1886.



All the other provinces of the Argentine Confederation cut off communication with the capital, suspended the course of railway trains and the diligences, and established cordons which did not allow of intercourse with any one from without. The rigor of these measures, however, did not save them from invasion by the disease, for on the 14th the first cases of cholera appeared in Rosario.

The cable notified us daily of the progress of the epidemic, which extended into the interior, invading successively Cordova, Tecumán, and Mendoza, by land, and reaching Montevideo by sea.

From the banks of the Plata, surmounting the Andes, the cholera has, for the first time, made its power felt in the neighboring republic of Chili.\*

On the 26th of last December the first cases of cholera appeared in that country, in a village near the Andes, and from that date to the 5th or 6th of the month 114 cases and 64 deaths have occurred.

It is not always that industry and commerce or war have caused an introduction of cholera into villages; in many cases it has also been by errors of administration. In reference to the present epidemic, the way in which the ports were opened to cholera in Egypt in 1883, and in Buenos Ayres in 1886, can not but be censured.

Among the first-named people there was, as a means of protecting themselves against cholera, an international sanitary council, which ordinarily enforces quarantine as a means of observation of the multitudes of ships which, after a short voyage, arrive from India (above all, Bombay), when the English occupation of Egypt took place and the presidency of this council came under the authority of that nation. This authority at first interfered with, and afterwards imposed itself upon, the deliberations and decisions of the council. At length, prompted by its commercial interests, it suddenly suspended the old system of quarantine and gave rise to the passage of cholera from Egypt to the shores of the Mediterranean, and was responsible for the subsequent ravages in France, Spain, and Italy.

In Buenos Ayres, where it was not unknown that cholera existed on the coasts of Europe, especially in Italy, a nation with which the communications were constant and frequent, through deference to an official personage (the Argentine minister at the court of King Humbert), who came from Italy in a suspected ship, free pratique was given without the usual precautions, and, with the passengers, the cholera penetrated the city. Not long before it had been saved from this plague by energetic measures which her authorities and those of Montevideo had enforced against other ships, which, loaded with passengers and immigrants (the *Matteo Bruzzo*, for example), had attempted to enter them, but unsuccessfully. These vessels were obliged to return to Europe, and were made an example of the austerity with which these authorities performed their sacred duty of watching over the lives and health of their people.

By the commission of similar errors, the English introduced cholera into Europe, and Buenos Ayres received the disease. After that the scourge traveled in its accustomed manner, by the aid of steam, inland trade, and water, as far as Valparaiso, the principal port of Chili, which was attacked for the first time by the East Indian visitor.

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#### NOTES UPON THE CHOLERA IN BUENOS AYRES.

By Dr. JOSE M. CABEZON.†

The first suspicious case occurred on the island of Maciel, situated in a stream of the same name at the mouth of the Riachuelo (mouth of the Rio de la Plata), but the source of the importation could not be precisely discovered, it having been attributed to the transatlantic steamer *Perseo*, which arrived October 12 from infected Italian ports. It is of small importance to designate the particular ship which brought the scourge into the republic, for it might have been in one of the packets which sail semi-monthly between the ports of the Mediterranean and Buenos Ayres.

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\* La Cronica Medica, Lima, No. 37, January 31, 1887.

† Revista Argentina de Ciencias Medicas, January, 1887.

The germ was planted in a soil well prepared and favorable for rapid germination and propagation. Riachuelo, with its stagnant and infected water, and with a population of dirty sailors having no hygienic habits, lent itself admirably to the development of cholera. Upon the public announcement of the first cases made by Dr. Seco, physician to the prefecture of La Boca, there was a general stupefaction; and some physicians denied from the first the importation of Asiatic cholera, classifying the disease as *cholera nostras* or cholérine, usual to the climate and the season.

But very soon the rapid spread of the disease, its malignant and fatal character, and its extension beyond the locality, demonstrated the error and proved certainly that we had the visitor from the Ganges for our guest, who intruded his presence without warning or welcome. Subsequently Rosario, and some wards of the capital, were invaded, and then real measures of prevention began to be taken. Riachuelo was isolated by prohibiting absolutely the entrance of all ships.

A lazaretto was established on the island of Maciel. Cleaning of the streets and of the dwellings, and closing of the latter when found in bad condition, were ordered. The obligatory use of boiled water was prescribed; the taking of fish from the contaminated water of the Riachuelo was prohibited, and the creation of a daily service for removal of excrement and filth in the streets was thought of.

Thanks to these measures, the cholera diminished in La Boca; but because access to the city was easy (and rigorous isolation of the locality had not been thought of at first) the disease slowly spread to the capital, and in the space of one month 15, 20, and 30 cases daily occurred during December, and increased in a short time to as many as 45 daily, with a mean mortality of 50 to 60 per cent.

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CONSULAR AND LEGATION REPORTS ON CHOLERA IN MONTEVIDEO, 1886-'87.

The United States consul at Montevideo reports, in a dispatch dated December 6th, 1886:—It is officially stated that there has not been any cholera here. I believe there has been, but it is confined to the poor-house, and I am not willing to cable the Department until I have better reasons for doing so.

The same consul reports December 10th: On the 6th instant it was rumored that there had been 2 cases of Asiatic cholera, but it was officially denied on the following day. On the 8th the newspapers and many physicians acknowledged 12 cases and 5 deaths, in the poor-house, but yesterday and to-day, as there have been no new cases, it is strenuously denied by all. The place is very much crowded and in a filthy condition, and it is now claimed that the sickness was brought on by the eating of the animals killed in a "bull-fight" on the 5th instant. While I believe it to be a mild form of cholera, I do not anticipate an epidemic, as the sanitary condition of the city is first class. I shall not give a clean bill of health to vessels going to the States, but shall not cable the Department until I am more fully satisfied that it is cholera.

The following dispatch was forwarded January 7th, 1887, from the same consulate: It is officially denied that there has been a single case of Asiatic cholera in Montevideo, but from time to time since December 8 it has been rumored that certain people have died from what was supposed to be cholera. It was an impossibility for me to learn the exact truth, but if there is any cholera it is of a mild form, and as the city is in a very cleanly condition I do not anticipate an epidemic. The quarantine laws are strict and strictly enforced, this port being closed against the Argentine Republic and Paraguay. I still decline to give a clear bill of health, but I learn that some vessels are leaving here, with ballast, for Barbadoes, calculating upon getting clean papers from there to the United States.

Again this consul reports January 17, 1887: From reports made by parties who for the past two weeks have been investigating the matter for me, I am satisfied that there is and has been some cholera in Montevideo since early in December. It seems to be of a very mild form and spreads but little. Some days since the president of the board of health wrote me that



he had no official knowledge of cholera, and that the health of the city was first class. I shall make another attempt to-day to get an official acknowledgment, and shall cable the Department whether I succeed or not.

After these repeated evasions and denials on the part of the officials our consul at Montevideo cables the Department of State, January 19th, 1887:—"Cholera officially declared."

The United States minister at Montevideo informed the Department January 15, 1887, as follows:—On the 10th instant there was a quasi official declaration that the cholera was epidemic in this city. It arose in this way: The Government having asked the board of health whether the current reports as to the cholera being epidemic since the 8th of December last, were true, that board replied that, according to the best information in the possession of the board, it had not existed until the 8th of January. The answer, you will see, does not state that it was epidemic, but "existed." Indeed, the words are rather evasive: "El colera no existe en este ciudad de Montevideo sino despues del 8 de enero del presente ano."

The "Siglo," however, the most reliable journal, perhaps, of the city, alluding to this reply said that the board of health had officially declared the existence of the germs of cholera. I am of the opinion, from what I can hear, that the cholera is either epidemic or endemic. I have not deemed it my duty to "cable" as to this matter, as the worthy consul here is especially charged in this regard, and I know is making efforts to ascertain the real condition of affairs in order to cable if necessary.

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#### *HISTORY OF THE INTRODUCTION OF CHOLERA INTO CHILI.\**

No country could be better situated than Chili to withstand the attempted invasion of such a disease as cholera. No better boundaries could be desired than the extensive desert on the north, separating the country from Peru and Bolivia; the Pacific on the west, and the unbroken mountain range on the east. The Andes, furthermore, form a natural water-shed, thus preventing contamination of the water-supply by the inhabitants of neighboring countries. The sole danger, therefore, lay in importation of the disease by infected clothing or in the person of fugitives from the eastern side of the mountains. Every port of Chili was absolutely closed to vessels coming from the eastern coast of South America, and guards were stationed at the mountain passes. A dozen of the most frequented passes were closed, but, the winter being a dry one, the fall of snow was light, so that more than a hundred of the less well-known passes are said to have been open.

The introduction of the disease was traced directly to a party of fugitives coming from the Argentine Republic. A cattle dealer, with four servants, crossed the mountains and remained concealed for a time in the village of Santa Maria. One of the number was sick, and five days later, on Christmas, 1886, the first authentic case of cholera occurred in the person of a laborer in that village. As soon as the nature of the disease was recognized, a military cordon was placed around the infected district, and the branch railroad leading therefrom was closed.

But an exodus from the place had already commenced, and on December 30 one of the fugitives died immediately after his arrival at a small station of the main railway line, 45 miles from the sea-port. Four days later the man who had attended this case sickened and died, and thus a second center of infection was established.

This case was an exception to the general manner of the spread of the disease, the water having been the carrier of the infection. In Chili artificial irrigation is relied upon in agriculture, and the river water is carried through small canals (acequias), traversing the valleys in every direction, and furnishing the supply needed for cooking, drinking, and washing. The canals then act as sewers, the water-closets being built over them, and are next used for purposes of irrigation, and finally empty again into the river. No cordon could be of avail under such circumstances, and it was along the banks of the acequias, carrying the waste water from the

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\*The account of the introduction of cholera into Chili was given by Dr. John Trumbull, in a letter to the New York Medical Record, April 30, 1887.

village of Santa Maria, that the disease next disclosed itself. After that a section of country, miles away, but on the banks of the same river, and drawing its water-supply from this source, was invaded. As yet the disease has not spread from the district supplied by the Aconcagua River, but several suspicious cases have appeared elsewhere, and much anxiety is felt concerning the future.

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*CONSULAR AND LEGATION REPORTS RELATING TO CHOLERA IN CHILI.*

The United States minister at Lima, in his dispatch under date of January 5, 1887, states that prohibition was made against all ships from Chili leaving her ports after December 20; that the measure is precautionary, and the immediate provocation he understands to be the appearance of cholera in Chili, at San Felipe, which town is said to contain about 10,000 people, and is the capital of the province of Aconcagua, situated near the base of the Andes, some 38 or 40 miles north of Santiago. A telegram on the 2d instant reported 55 cases and 40 deaths as having occurred there, but on the succeeding day there were no new cases. The same telegram reported that vigorous measures had been taken, and the locality had been isolated by a sanitary cordon. A telegram received from Chili, dated the 5th instant, communicated through the Chilean legation here (Lima), reported that the first case of cholera occurred December 26 in the east of Aconcagua, and that the epidemic district, circumscribed to a square league, is absolutely isolated by the army in three successive lines of sanitary cordon, and it is hoped to thus extinguish it.

The United States minister to Chili, in his dispatch, dated January 15, reports: Cholera is slowly extending along the valley of the Aconcagua, following the course of the river towards the sea, near Valparaiso. About 600 cases have so far been reported, of which about 250 have proved fatal. The victims are almost exclusively confined to the poorer classes of people. Every precaution possible has been taken by the authorities to check the spread of the disease, and stringent sanitary measures adopted, especially in the cities of Santiago and Valparaiso, and as a result for the last month these cities show a death-rate less than has ever been known at this season. The following dispatch from Iquique, dated January 5, appeared in the press of this city (Santiago): "The Peruvian Government has determined to take active measures against the cholera, and has ordered the closing of all the ports against vessels coming from infected countries." This very extraordinary and premature action of Peru in closing all her ports against vessels from the ports of Chili, with its vast line of sea-coast of over 2,500 miles in extent, and stretching along the Pacific from Arica, on the borders of Peru, to Cape Horn, because cholera appeared in a section of Chili midway between the points mentioned, may be likened to a European nation closing its ports to vessels from the United States because cholera had appeared in Connecticut. It is unnecessary for me to point out how very seriously this action of Peru affects our interest. All the steam-ship lines have been withdrawn from the route between here and Panama, so that the Pacific from Panama to Cape Horn is practically closed to our commerce and communication by steam. All the traffic and commerce from this coast have now to go to Europe, and this dispatch will leave Valparaiso on the 18th instant for Lisbon, thence by rail to Paris and Calais, thence by Liverpool to New York, and will probably take fifty days alone in transit.

Our consul at Callao, Peru, dispatched the Department of State, January 27, 1887, as follows: The cholera in Chili seems to be decidedly on the increase, and on the 25th instant the Peruvian minister at Santiago cabled that cases had appeared at that capital. The cable messages are so laconic and so few in number as to leave one in doubt as to the magnitude of the epidemic.

In a postscript to this dispatch the consul gives later information from Santiago, as follows: Cholera in force. Suburbs and various central districts of city attacked. Twenty deaths yesterday in the lazaretto from cholera. Government has declared city infected. The pestilence is being combated with energy and activity. The Peruvian consul at Valparaiso informs the foreign office at Lima, January 27, 1887, of the appearance of several cases of cholera in the former city.



Again under date of February 1, 1887, our consul at Callao writes: Even in the unexpected event of cholera reaching Peru there would be small probability of the communication of the pestilence to the United States from this country. Occasionally a ship leaves Callao for Puget Sound, and a few carry nitrate of soda to our Atlantic ports from Iquique. With these exceptions there is no direct communication. To reach New York or New Orleans the traveler would necessarily have to pass over the Isthmus of Panama, and the authorities there, already alarmed at the appearance of the disease in Chili, have closed their ports against all vessels that may arrive from Chilian waters. By this time, of course, the attention of the health officers at San Francisco has been directed towards averting the possible danger, and doubtless orders have been given respecting vessels and passengers from the infected countries. The last reports received from Chili are more satisfactory in character. According to the official information furnished to the Government by the Peruvian minister at Santiago the cases of cholera in that city for the three days ending on the 29th ultimo were only one hundred and the deaths few. To this same authority were disclosed free from the pest, by which we understand that it has disappeared, and cases were reported at that place by the consul of Peru only a few days since.

The absolute suspension of all commercial as well as the ordinary personal intercourse between Peru and Chili, established as a precautionary measure, is discouraging in the extreme. The volume of trade between the two countries is very large and important, Peru supplying Chili with sugar, tobacco, aguardiente (a pure brandy), rice, rum, fruits, etc., and in return receiving Chilian wheat, barley, baled hay, mules, and horses. The value of the interchanged merchandise amounts yearly to between five and six millions of silver soles. It is also the custom for most vessels arriving on the coast with coal and lumber to call in at Valparaiso for orders, and, as has been stated, by so doing the northern ports are closed to them.

In a postscript to this dispatch is the following: Last official cable message published from Peruvian minister at Santiago to Government at Lima. "Santiago, February 1, 1887. Last two days 120 cases, 70 deaths."

A later dispatch from our Consulate at Callao, February 19, 1887, reports considerable severity of the epidemic at Santiago: The cholera is still confined to Chili; no cases have appeared in Peru. The latest official intelligence is contained in the following cable messages from the Peruvian legation in Chili to the Government at Lima: "Santiago, February 15. From Saturday to Monday noon 435 attacks and 213 deaths. It is difficult to obtain exact data." "Valparaiso, February 15. I have visited the lazaretto established on the Baron Hill. Seven cholera patients. Freight from Santiago enters free; passengers quarantined for twenty-four hours." The health of Lima and Callao is exceptionally good; strict sanitary precautions and hygienic regulations are still observed.

The United States consul at Callao, in his dispatch under date of June 7, 1887, thus announces the termination of the epidemic in Chili: "The Government of Peru has removed the restrictions adopted respecting vessels from Chilian ports during the prevalence of cholera in that republic. Now that official advices have been received announcing the total disappearance of the epidemic in Chili, the ports of Peru are re-opened to shipping proceeding from those of Chili after a medical examination has been practiced, and the vessel declared in full pratique. The effects of this measure will be beneficial in the extreme to Callao."

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#### LEGATION REPORTS RELATING TO CHOLERA IN BOLIVIA.

Concerning cholera in Bolivia, the United States minister at La Paz, in his dispatch dated February 6, 1887, thus reports: The cholera is the all-absorbing question of the day. The Government has organized very stringent preventive regulations, and is anxious that other nations should not disapprove of them. While they weigh very heavily on commerce, the people generally are inclined to approve of them.

When the disease assumed an alarming shape in the Argentine Confederation non-intercourse was proclaimed by the Bolivian Government, and maintained by a military cordon.

The port of Arica, near Tacna, though closed to northern vessels, being open to the south, is liable to be infected at any moment. Hence a military force guards the mail route to La Paz, and prohibits all ingress from that direction.

The moment a case occurs, either in Arica or Tacna, liable to happen any day, the steamer on the lake will be stopped and intercourse with Mollendo and Arequipa suspended, thus cutting off communication with Mollendo, if open, and with both mail and cable routes to the rest of the world. Bolivia will then be completely isolated.

Can the cholera be kept out? This is an important question, because places of refuge in Bolivia are wanting, and most of the cities are so filthy or fall easy victims to the plague.

In two months more the cold weather may prevent its spreading to the northward, and thus save Arica, Tacna, and Bolivia. But if it should escape to Mollendo and northward, there is nothing to prevent its spreading all along the warm countries of the western coast, and remaining there indefinitely.

The United States consul at Callao, under date of March 6, 1887, speaks of cholera in Bolivia as follows: There is as yet no appearance of cholera in Peru. Some cases have been reported on the eastern frontier of Bolivia, doubtless proceeding from the Argentine Republic, and energetic measures were being taken to prevent the spreading of the disease. Should the presence of cholera become more manifest in Bolivia, the necessary sanitary precautions will be adopted towards that republic. Later advices, however, state that the reports alluded to are unfounded.

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#### BAD HYGIENE OF THE INHABITANTS OF SOUTH AMERICAN TOWNS.\*

The following arguments in favor of the establishment of lazarettos for the proper management of infectious diseases, which have wide epidemic prevalence at times, were offered by a member of the South American Sanitary Congress, convened in 1887, at one of its meetings. At the same time it throws valuable light upon the hygienic condition of the people, and on that account finds a place here:

To deny the advisability of lazarettos is, in our opinion, to be totally ignorant of the nature of this terrible disease (cholera) and to ignore also the habits of our population. Whoever is acquainted with the conditions under which our people live can not rationally deny the advantage or even the absolute necessity of the establishment of lazarettos. Our proletariat classes generally live in "conventillos," which do not meet any hygienic requirements and in which there is great crowding, where, consequently, contagion may spread rapidly. The families are generally composed of five or six persons, who live in the same room, in which there is one bed, and sometimes none.

Suppose cholera appear in one of these houses. The patient should go to bed and be well covered; vessels for the reception of dejections and vomit are needed; a thousand necessities are required, which call for a careful disinfection before use. What happens in such a case? That in the same room, or conventillo, a crowd of persons remain who are not wanted for the care of the sick and who are exposed to the contagion; that the dejections, disinfected or not, are thrown into the drain, or into the court, thence to propagate the epidemic. If the patient dies the clothes used by him, which usually are concealed in order to avoid disinfection or burning, serve the other members of the families and certainly cause new victims.

There are multitudes of cases in which this state of affairs has been evident, where six and seven persons have perished in succession, victims of the scourge. If the first patient had been sent to a lazaretto, is it not probable that the other victims might have been saved?

The lazarettos for these uses should be small, not containing more than fifty or sixty beds, numerous, and scattered through the population at small intervals. These are more advisable than large ones located at distances from each other, for "*there is no cholera patient who can survive an hour of transportation.*"

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\* El Monitor Médico, No. 53, August 1, 1887.



## SUMMARY REMARKS CONCERNING CHOLERA IN SOUTH AMERICA.

The two Americas, it would seem at first thought, were equally exposed to an invasion of cholera, from southern France or from Italy. Large numbers of emigrants year by year sail from the Mediterranean destined for the United States on the one hand, and for certain ports on the eastern coast of South America on the other hand. Direct maritime communication, by means of large steamers carrying swarms of emigrants, the great body of whom are Italians, is constant between the port of New York and the Mediterranean, as it is also between that sea and the chief ports of Brazil, Uruguay, and the Argentine Republic.

When, therefore, cholera became epidemic in Italy, especially in and around her two principal maritime cities, the danger of importation of cholera directly from Italy, into North or South America, or both, was regarded by many experienced sanitarians as imminent. The larger mass of Italian emigration seems, however, to have been towards South America, during the earlier periods of the cholera epidemic in Italy; and stringent measures looking to exclusion of cholera-laden steamers were early adopted at the chief South American ports on the Atlantic coast. At the same time there was a degree of alertness displayed by the New York quarantine officials in view of the danger, although it was believed by them to be small, of introduction of cholera into North America through that port, which was practically the only one through which this country was seriously threatened.

We have already seen how cholera was carried on board the *Matteo-Bruzzo* from Genoa to the south Atlantic coast of South America during 1884, and how the danger therefrom was successfully averted by the absolute closure of the ports to that infected steamer. It has also been shown how through the obsequiousness of officials to a diplomat, and the interests of the ship's officers cholera finally gained a foothold on the South American continent, about the end of the autumn of 1886, where by reason of conditions made very favorable by the bad hygiene of the inhabitants the epidemic widely spread. After penetrating to the interior confines of the Argentine Republic, the scourge for the first time in the history of its periodical wanderings, scaled the Andes, heretofore believed to be an impassable barrier to its march, and planted itself upon the soil of Chili, never before invaded by such a disease. There also the conditions of life of the inhabitants were just what have been always found in other countries so favorable to the development and spread of epidemic cholera, the seeds of the disease once being planted. In Chili, the first advance of the cholera, it will be remembered, was along the course of small streams and irrigation canals whence the neighboring population were accustomed to draw their drinking water, where they were used to washing their clothing, and into which not unfrequently also the village drainage went. In the miserable hygienic conditions surrounding the homes of the South American villages and cities, and in the untidy habits of the populace, and the bad quality and ready polutability of the drinking water are found reasons why the Asiatic cholera committed havoc and became uncontrollable in the localities where, by the movement of infected persons or their infected clothing, and by the course of infected streams of water, the seeds of the disease effected an entrance. It is the same old story, repeated in South America as elsewhere. The same bickerings and disputes and vacillations on the part of health authorities and physicians, concerning the real nature of the first invasions and the necessary choice of measures to prevent the development of an epidemic, which have been animadverted upon when considering the course of cholera in other countries, characterized nearly always the advent of the cholera in the affected towns of that continent.

In South America as elsewhere, it was only after the cholera had become well rooted to the soil and the seeds of the disease had been pretty widely scattered, that the general and local governments became thoroughly awake to the need of wise and vigorous action—too late to exercise much control over the march of the epidemic. It is safe to say that had one-tenth the energy and money expended during the course of the epidemic been exhibited at the very outstart they would probably have nipped this South American epidemic in the bud. It is also probable that the occasion for writing of cholera in South America might not have arisen,

had not the unscrupulous officers of the *Perseo* concealed the existence of cholera on board and the over obsequious officials permitted the landing of the Italian minister and with him some hundreds of Italian immigrants among whom the disease was slumbering.

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## SECTION 9.

### CHOLERA IN EASTERN ASIA.

#### CONSULAR REPORTS RELATING TO CHOLERA IN CHINA.

The consul at Shanghai, September 10, 1885, reports as follows, concerning the sanitary condition of Old Shanghai :

In obedience to the Department's instructions, dated April 9, 1885, I this morning cabled as follows : "Cholera prevails." At my request Dr. Neil McCleod has favored me with the following information : "During the last week in August the deaths from cholera in the English and American settlements are reported to be 96 amongst the Chinese. The returns for September have not been sent in, but I think the number is not, probably, less. The deaths amongst foreigners have not yet, I believe, exceeded 10. I have no means of determining the number of cases."

I am advised by the superintendent of police, and by the Chinese officials, that in the native (old) city of Shanghai, and its suburbs, with an estimated population of 300,000—which is not referred to in Dr. McCleod's communication—the cases of cholera are exceedingly numerous. No statistics are obtainable. The walled city of Shanghai is the filthiest city I have ever visited. Old residents of China have told me that it is considered to be at the head of the list of Chinese cities, so far as filth and vile smells are concerned. A few days ago I made a tour of inspection through the city, and found vegetable and animal carbage festering on every hand. Human excrement is carried out of the city to be used in fertilizing the fields, and as it is carried through the streets in open buckets, the air is constantly charged with vile odors. And, besides this, numerous public latrines are scattered about, and the temporary occupants are in full view of passers by. These latrines are rudely constructed ; no attempt is made at disinfecting them, and they must be the direct cause of a great amount of sickness. The streets are narrow, and the dwellings low and damp. The only wonder is that the mortality is not greater.

A dispatch from the consulate at Foochow, September 18, 1885, reads as follows : It is proper for me to report to the Department that within the last few days frequent deaths from cholera of natives in this vicinity have been reported. I do not, however, understand that the physicians consider it epidemic, or that it exists at all at the anchorage or among the shipping. Clean bills of health can, therefore, still be given. Sporadic cholera may be said to always exist here, and under circumstances favorable to its development, its outbreak is more or less violent. The month of August up to the 24th was very hot and dry. On the 24th was the typhoon, followed by much rain. The rain continued with little intermission up to the 14th of September, the last few days having been unusually cold. The houses of many of the poor must have been very damp as well as dirty, and it was during these last days that deaths from cholera were reported to be most frequent. It is worth noting that of 27 deaths from cholera, which are said to have occurred in one direction within a quarter of mile of this consulate, on the 12th, 13th, and 14th instant, the whole 27 were either men or boys, all of whom had been taking part in an idolatrous procession which had paraded the streets in the night and rain for the purpose of warding off the disease. Such occasions are always accompanied with much imprudent eating and drinking, thus fitting the participants for an attack and rendering them unable to recover when once ill. The parading of the idols, called by foreigners "The Tall White Devil," and "The Short Black Devil," comprise the various sanitary measures employed in Foochow to prevent the ravages of cholera. So far as I can learn, the disease is abating somewhat during the last two or three days of sunshine.



## CONSULAR REPORTS RELATING TO CHOLERA IN JAPAN.

## CHOLERA AT KANAWAGA.

The consul at Kanagawa, Japan, August 31, 1885, wrote the Department of State as follows:

On the 28th instant I received a dispatch from the United States minister at Tokio, announcing the outbreak of cholera at Nagasaki and vicinity, and requesting me to publish a notice requiring all masters of American vessels and all citizens of the United States in Japan to conform to the regulations of the Japanese Government, as set forth in the Imperial Decree No. 31, for the inspection and detention of vessels arriving from an infected port.

With the dispatch was the following inclosure relating to quarantine and the disposal of the dead in Japan:

*“Imperial Decree No. 31 (dated 23d of the 6th month, 15th year Meiji).—It is hereby decreed that vessels arriving from localities infected with cholera shall be inspected according to the following regulations. Regulation for the inspection of vessels arriving from localities infected with cholera:*

*“(1) All vessels arriving from localities infected with cholera shall be subjected to medical inspection, and no vessel so arriving shall proceed to her destination, or communicate with the shore or other vessels to land her crew, passengers, or cargo, until a written permission so to do, signed by one of the inspecting officers, shall have been so granted as hereinafter provided.*

*“(2) When there are no cholera patients or bodies of persons who may have died of the said disease on board such vessels, the inspecting officer shall forthwith grant permission to such vessels to proceed to their destination, and communicate with the shore or other vessels to land their crew, passengers, and cargo.*

*“(3) Vessels so arriving and having on board cholera patients or the bodies of persons who may have died of the said disease shall be required to anchor at a place designated by the inspecting officers at a safe distance from the land and other vessels.*

*“The patients shall be sent to the quarantine hospital, or to their residences or other places which the inspecting officers may deem suitable. The dead bodies (if any) of persons who may have died of said disease shall (at the option of persons interested, if any) be either burned at a place prepared by the local authorities for that purpose, or buried, after undergoing thorough disinfection, at such place as the local authorities may designate.*

*“After final disposition of such patients and dead bodies (if any) shall have been made, the inspecting officers shall thoroughly disinfect the crew and passengers, and shall thereupon grant permission for them to land. The inspecting officers shall thoroughly disinfect said vessels and such portions of their cargoes as may be considered to be of any infectious character, and thereupon grant permission for them to proceed to their destination, or communicate with the shore or other vessels, and to land cargo.*

*“(4) Any person or persons who shall contravene or infringe the provisions of the foregoing regulations, or shall in any manner interfere with the execution of said provisions, shall be punished according to the criminal code.*

*“(5) The localities where these regulations shall be put in force, and the length of time for which they shall be continued in force, will be determined from time to time by the minister of the interior.”*

The consul at Kanawaga, Japan, July 19, 1886, writes concerning cholera in 1886: “I have the honor to confirm my telegram of this day addressed to the Department. This telegram was sent in consequence of official notification given me by the governor of Kanawaga to the effect that, owing to the cholera having assumed a severe epidemic form in this neighborhood, sanitary inspection and quarantine will from now and until further notice be enforced with respect to all vessels arriving at any Japanese port from Yokohama.

“The disease first made its appearance here June 3, 1886, since when 648 cases and 267 deaths have been reported.”

## CHOLERA AT NAGASAKI.

The consul at Nagasaki, Japan, December 18, 1885, wrote concerning cholera as follows:

Referring to my dispatch to the Department of State, dated November 16, 1885, in relation to the port of Nagasaki having been declared free from cholera, I now have the honor to add the following: The epidemic of cholera in Nagasaki Keu from its first outbreak, August 13 up to November 14, when the port was declared free from the disease, comprises 4,435 cases, of which 1,500 were in the city of Nagasaki and 800 in the Takasima Colliery, the remaining cases being in the surrounding towns and villages. Of the persons attacked 2,927, or considerably over one half, died.

The most fatal week was from August 31 to September 6, when there were 211 deaths reported, after which there was a gradual subsidence of the scourge. The dead were in most cases cremated. The regular crematories not being of sufficient capacity for the large number of corpses, trenches were dug in the earth, filled with fagots, and covered with iron bars, the bodies placed on the grating, and the fuel lighted underneath; they would be reduced to ashes in from ten to twelve hours.

It is proper in this connection to say that while the disease was unusually fatal to the natives the foreign residents were peculiarly exempt. Great credit is due to the authorities for the exertions made to prevent the spread of the disease to the surrounding ports.

The consul at Nagasaki, August 13, 1886, reported:

I regret to report that this port was officially declared infected with Asiatic cholera on August 9. The disease made its appearance July 18, and from that date until August 9, there have been in Nagasaki and vicinity 581 cases and 320 deaths. It was hoped that by reason of the stringent sanitary measures adopted by the Government the cholera would not become epidemic here this year; and as yet there are grounds for hoping that continued vigilance on the part of the sanitary and police authorities in the matter of enforcing cleanliness and prohibiting the sale of unsound fish and unripe fruit the cholera experience of last year will not be repeated.

In every case of sickness resembling cholera that occurs the patients are at once removed to the cholera hospital for special treatment according to the symptoms. The houses in which the sickness has occurred, together with the entire contents, are thoroughly disinfected, and the entire block of houses adjoining, placed in strict quarantine for one week. At the expiration of this time if no fresh cases occur the quarantine is removed.

Free tickets can be obtained from the governor of the Keu by all poor people, entitling them to medical attendance and medicine gratis in the event of their being attacked with symptoms of cholera or diarrhœa. The physicians finding other expenses incurred in connection with these free tickets, are paid by the Government. Those who die from the disease are cremated.

Advices from Korea inform us that cholera is raging very badly throughout that country, and in the capital, Seoul, where the sickness is probably worse than in any other part of the country, the deaths numbered over 600 daily. While the disease is unusually fatal to the natives of these eastern countries, foreign residents who have not adopted the native food and manner of living are peculiarly exempt.

The consul at Nagasaki, Japan, December 27, 1886, reported as follows:

I have the honor to inform you that the port of Nagasaki was officially declared free from Asiatic cholera November 6th.

The epidemic of the present year in Nagasaki Keu, owing to the speedy and vigorous restrictive measures adopted by the Government, was not so severe as last year. In 1885, between the 13th of August and November 14th particularly, the limits of the duration of the disease, there were 4,435 cases, and 2,927 deaths. This year, from the first outbreak, August 9th to November 6th, when the port was declared free from cholera, there were 2,384 cases, and 1,551 deaths, while the character of the disease was as severe, and the percentage of deaths about the same as last year, being about 65, the number of persons attacked is less by over 2,000.



At the Takasima colliery, located on the small island of Takasima, near the port of Kanawaga, the point at which last year the epidemic raged with great severity, so much so that of the 4,000 men employed in the mines, 1,500 were attacked, and 800 died, the disease was successfully combated. As the working of the mines had been brought almost to a standstill in 1885, owing to the scourge, and as it was the third or fourth time that the island had been invaded with cholera, the owners of the mines, the Nitsu Bishi Company, determined to try such preventive means as modern science could suggest. They were enabled to undertake comprehensive measures inasmuch as the island of Takasima practically belongs to and is governed by this company.

During last winter, extensive operations under the supervision of Mr. John Stoddard, the mining engineer and manager of the extensive workings, were accordingly undertaken, and from him I obtained the following particulars, believing that they would be of interest to the Department.

A complete sewerage system was formed. This consisted of heavy pumping arrangements, which were erected on the beach for the purpose of pumping sea-water up to the highest point in the island, whence, by an arrangement of drains and sluices, it was gravitated back to the sea, flushing for two or three hours daily every drain among the dwelling-houses, some of the larger drains being kept with a constant flow of water in them. All drains were made open, to facilitate inspection as to cleanliness, etc. Owing to the extensive underground workings, there are no good fresh-water wells on the island, the main portion of the drinking-water requiring to be brought from the mainland in water-boats. As the purity of this water was more or less open to suspicion, an extensive fresh-water condensing apparatus was erected, consisting of three large Lancashire boilers and three condensers, the whole plant turning out from 7,000 to 8,000 gallons per day. The wells on the island were closed, and water from the mainland only allowed to be imported for purposes of washing, etc.

The greatest difficulty was encountered in regulating the food supply, as the working people are ignorant, prejudiced, and accustomed to a diet consisting wholly of fish and vegetables—unripe fruits and raw vegetables being an especially favorite diet—and their method of cooking being at best uncleanly, and cheapness being looked upon as a greater desirability in fish than wholesomeness and freshness. To obviate these difficulties, a strict system of food quarantine was instituted during the cholera season, and all food was supplied through the company. Three large Papin's digesters, each of 500 gallons capacity, boiling at a pressure of 10 pounds, were erected; beef killed under inspection being used to make soup, which was supplied to all the miners, about 1,000 gallons per day being made and supplied. Beef was also served out in the rations. All surface-swimming fish—mackerel, sardines, etc.—and all shell-fish were prohibited, only deep-water fish, after inspection, being allowed to be landed and sold. No cucumbers, melons, stone-fruits, or deleterious vegetables of any kind were permitted to be brought to the island, potatoes, beans, and certain harmless native vegetables being the only ones allowed for consumption. The success of the system adopted has been amply demonstrated by the fact that Takasima has been the only place in Nagasaki-Keu untouched by cholera during this year's epidemic. It may be interesting to note that the treatment used by Dr. Nakamura, the chief surgeon of the mines, during the visit of the cholera last year, was remarkably successful. This is evidenced by the fact that, whereas the proportion of deaths to cases in the city of Nagasaki was about 90 per cent., in Takasima it was only about 50 per cent. Dr. Nakamura depended greatly on spirits of camphor and morphine in the initial stages of the disease (even to subcutaneous injection in the severe cases), and on morphine and atrophine in the collapsed stages, in this stage morphine and atrophine being injected. He reports an interesting case of the latter treatment which occurred this year on a neighboring island of Nakanosima, in which a cholera patient was kept alive, and in the end restored to health, who had been for forty-eight hours without a perceptible pulse. He is emphatic in requiring the abstention from liquids by the patient in the fever stage of the disease.

While the cholera experience of 1885 has not been repeated in Nagasaki and vicinity, in 1886 the epidemic has raged with virulence in other parts of the Empire of Japan.

In 1854, in the localities invaded, there was a total of 154,373 cases and 101,695 deaths. When we compare these figures with the cholera statistics of 1885 we realize how much more severe the epidemic was in 1886. In 1885 there were altogether 11,928 cases and 7,152 deaths, the proportion of mortality being about 90 per cent. ; this year the proportion of mortality was about 66 per cent. of the cases attacked. We may say that the cholera in Japan during the past year has spread widely, has been exceptionally severe, and the percentage of deaths enormous. The mortality is appalling when we consider that the disease has been combated with usual activity and with all the resources of modern science.

## CHOLERA AT OSAKA AND HIOGO.

The consul at Osaka and Hiogo, Japan, September 10, 1885, reported :

I presume the Department has ere this been duly advised of the existence of cholera at Nagasaki. On the evening of the 29th ultimo the U. S. S. *Ossipee*, en route from Nagasaki to Osaka, to receive and conduct Minister Denby to Tientsin, put into this port in distress, having lost three men during the passage. The commander, McGlesney, immediately advised me through the health officers of his situation, and solicited my assistance to aid him, and if possible to obtain permission from the local authorities to land the men at some suitable point for disinfection purposes.

I at once communicated with the governor of the Keu, who cheerfully granted permission, naming Wada Point near the light-house, and tendered the use of a large hospital in the immediate vicinity, with permission to erect such temporary houses as would be necessary according to emergency. The men were at once landed, the ship most thoroughly disinfected by the ship's officers by means of steam with battened hatches and afterward by the local authorities according to their system. Two deaths have occurred since the arrival of the ship in port. No deaths have occurred, however, since the 31st ultimo. By the prompt and energetic action of Commander McGlesney the disease has been thoroughly wiped out of the ship. At the hospital the number of patients is daily decreasing. Reports from the hospital and camp submitted to Commander McGlesney this morning are very numerous indeed.

The Japanese quarantine regulations have been duly observed by the commander from the very first, and he has not only submitted to their methods of disinfection but he has gone still farther and developed such methods as were prescribed by the medical inspector of the ship. The authorities have been exceedingly kind and rendered every assistance outside of the strict line of official duty. I feel quite confident that so far as the *Ossipee* is concerned the epidemic has been effectually checked.

In a dispatch from Osaka and Hiogo, September 19, 1885, the consul reports that notwithstanding the strict quarantine regulations forced by the local authorities as against all infected ports in Southern Japan the infection, whatever it may be, has broken out in Hiogo and Kobe, only separated by the river line. It is generally supposed to have been introduced by coolies handling coal from tankas shipped from the collieries at Takashima, in Nagasaki prefecture, and stated that up to midnight, October 16, 1885, there had been 101 cases, and 68 deaths in Hiogo, and 23 cases and 14 deaths in Kobe since the date of October 2. The population of Hiogo is 38,348 ; and that of Kobe, 16,073.

In a dispatch from the same consulate of November 7, 1885, cholera is mentioned as present in Osaka and the surrounding districts.

In a dispatch from Osaka and Hiogo, Japan, of May 31, 1886, the consul reports that the existence of cholera has been officially announced there and the port declared infected. The epidemic confined its attack to the native population.

In a dispatch from the same consulate a report was made of the cholera in the province of Osaka and the port and province of Hiogo, Japan, from the 1st of January to the 15th of July, 1886, inclusive. It is stated that while the epidemic is decreasing in Osaka and Hiogo it is steadily increasing in the province of Kanawaga and the port of Yokohama.



*MODE OF INTRODUCTION OF CHOLERA INTO JAPAN IN 1885.\**

In Nagasaki in 1885 the introduction of cholera was caused by means of the soiled clothing of a French naval officer who died on board ship. First, and indeed a very few days after the reception of the clothing, the washerman became sick and died, and almost at the same time his wife also. From them a chain of cases developed, until the epidemic was firmly established. Before this, Nagasaki, and as far as Dönitz knows, the whole of Japan, had been free from cholera for at least two years.

*HISTORY OF THE CHOLERA IN JAPAN.†*

Japan, in modern times, has suffered more severely from the scourge of Asiatic cholera than any other country within the belt of the temperate zone. Since I came here, in 1859, when the country was first opened to the western world, there have been two distinct periods of long epidemic prevalence of the disease.

The first, in 1860, was fearful in its death rate, and continued to destroy thousands during successive summers, till about the year 1867, when it died out.

As there was no systematic record of disease and death rate at that time, the sum total, or even an approximation to the power of the scourge, can be little more than conjectured. My own recollections, of the first two years especially, of this period are very vivid. Hundreds, and it is not too much to say thousands, died without even native medical aid, and in the cities near the sea the water was often their burial place.

In 1877, while acting as sanitary officer of the port and city of Yokohama, I recognized the first cases of the return of the disease here, which has been, as far as could be ascertained in the absence of any quarantine regulations, imported from China. In virtue of my office I was then charged with the preliminaries of applying, for the first time in the history of this country, the principles of modern sanitary science to an arrest or control, as far as possible, of cholera.

Notwithstanding the utmost liberality on the part of the Government, and the intelligence and untiring efforts of the native medical men in developing and perfecting sanitary measures according to the best known methods in the western world, it has not succeeded in forcing the disease from its strong hold upon the country.

In 1879 there were over 90,000 cases, and the statistical returns of the past year, just issued, mark a fearful total of 154,373 cases and 101,695 deaths.

Detailed and exhaustive reports of this year's sanitary work are now in course of preparation by the central sanitary board, in which the wonderful progress of this people in this important branch of science will be strikingly brought out. I would here say in advance that the most important feature of the sanitary system carried out in this country, quite eclipsing that adopted by the highly civilized western world, is the cremation of *all* dead from cholera.

Extensive appliances for this purpose are constructed on scientific principles in different parts of the Empire. In the city of Kyoto these appliances are on such a large scale that five hundred cremations can be made in twenty-four hours.

*CHOLERA IN QUEENSLAND.*

A dispatch from the consulate at Auckland, New Zealand, dated January 5, 1886, advises the State Department of an outbreak of cholera at Brisbane, Queensland, and of a proclamation having been issued by the New Zealand Governments, declaring that colony an infected place.

\* Bemerkungen zur Cholera-Frage, by W. Dönitz. Zeitschrift für Hygiene, Band I, 1886; from Baumgarten's Jahresbericht, zweiter Jahrgang.

† By D. B. Simmons, M. D., Yokohama. New York Medical Record, February 19, 1887.

## SECTION 10.

## CHOLERA IN THE PORT OF NEW YORK.

Although the epidemic of cholera asiatica of 1883 in Egypt attracted much attention in North America both from the standpoint of danger of an ultimate invasion of the United States and from the scientific side of the question, it was not until the vigorous outbreak of the disease at Toulon in 1884 and the rapid extension of the epidemic throughout Southern France and Italy during the same year that there was any real alarm exhibited in this country. Even then not a few writers for the public, as well as for the medical press, hastened to assure the somewhat disquieted people of the strong probability that this country would eventually escape this time. These assurances were apparently well founded, for they were based upon the well-known fact that heretofore cholera had reached the United States only from some infected port in northern Europe, for the disease was pretty well confined to the Mediterranean coast of France and Italy throughout the rest of that year and the next. Whilst an emigrant steamer was bearing the seeds of cholera towards the southeastern coast of South America in 1884 without effecting a landing and a lodgement of the infection, and another steamer was carrying a similar cargo destined to be landed in the capital of the Argentine Republic, in the latter part of 1886, and initiate an epidemic which finally spread across that continent, our own country seemed to be quite secure.

On the morning of September 23, 1887, however, the steam-ship *Alesia* arrived at New York with cholera on board. Eight patients were found sick on arrival, and a number had been seized and some had died during the passage. This steamer cleared from Marseilles August 29, where most of her cargo was taken on board. On September 3 she had cleared from Naples for New York, to which port she came direct. At Naples a large number of immigrants, some 600, with their personal effects, from various parts of southern Italy and Sicily, where cholera was then prevalent, were taken on board.

Besides the eight sick, all the passengers of the *Alesia*, except a few who were in the first cabin, were landed at the New York Quarantine Station upon Hoffman and Swinburne Islands, in the lower bay of New York. Some 26 attacks of cholera developed among the immigrants after they were landed at the quarantine station, and 18 deaths occurred.

Another French steamer from Marseilles and Naples, with immigrants from the latter port, arrived at New York at the end of the first fortnight of October of the same year, after having suffered slightly from cholera during the voyage. An attempt was made to conceal this fact, but fortunately, on account of one or two suspicious attacks among the children, the steamer was detained at the quarantine station, where, in a few days, the presence of cholera among the passengers was abundantly established, both by recognition of the cholera bacillus and by the occurrence of undoubted cases of cholera which subsequently developed.

Near the end of October the Italian steamer, the *Independente*, with a large number of immigrants, arrived at New York, and, not showing any cholera on board, was allowed to discharge her passengers, after a few hours of detention, necessary for a thorough inspection. The next day numerous squads of these immigrants, with their baggage, departed for divers and widely distant points in this country, such as Chicago, Cleveland, Philadelphia, New Orleans, St. Louis, Boston, Washington, Cincinnati, Pittsburgh, Baltimore, Syracuse, and Providence.

The cholera did not, however, extend beyond the limits of the quarantine station. Whether this limitation of the disease within the bounds of the quarantine islands in lower New York Bay was due to the efforts to restrain it, or to the lateness of the season, or to some unknown combination of fortunate circumstances, is difficult to determine. The condition of this quarantine station at that time will be described later. It is pretty generally believed, however, that had the disease passed the quarantine station and entered the country at a favorable time of the year, it would have found abundant filth in our cities to feed upon and breed a damaging epidemic.



## THE COURSE OF THE CHOLERA DURING THE LAST GREAT EPIDEMIC.

It has been seen that the Egyptian cholera epidemic of 1883 was preceded by epidemics of the disease in Arabia during 1882 and 1881, and that each of these Arabian invasions were immediately preceded by the presence of cholera on East Indian pilgrim ships conveying Mohammedan pilgrims from Bombay, where cholera was prevailing, to the Red Sea port for Mecca, meanwhile planting the seeds of the disease where these vessels stopped en route.

Although it has not been absolutely proven that the outbreak of 1883 in Egypt was due to infection from India, in view of all the circumstances it is highly probable that this was the origin of that epidemic, and there has been no other rational explanation advanced to account for that visitation.

It seems that cholera was really present in Marseilles during the summer of 1883, whilst its existence there was successfully concealed, and it is reasonably certain that it was brought into this city from Egypt. The epidemic broke out in 1884 at the great naval station of the French on the Mediterranean and quickly spread among the provinces of that country which border the Mediterranean, making excursions at times to considerable distances inland. The origin of the French epidemic of 1884 is obscured with some doubt, it being attributed by some to the Egyptian epidemic of 1883, by others to direct importation from Tonquin, where cholera was then raging, through French transports returning with troops which had been engaged in the Tonquin war.

From France the infection was conveyed to Italy in 1884, various parts of which kingdom were ravaged by cholera from that time up to 1887. From France the disease was also carried to Spain in 1884, but cholera did not spread extensively in that country until the spring of 1885. During the latter year this kingdom experienced one of the most devastating visitations of cholera which it has ever suffered. From France also the disease reached one of the Welsh ports of England but did not spread. It is believed also that a limited outbreak of cholera at Finthen and Gonsenheim near Mayence, which, owing to prompt and intelligent action on the part of the imperial Board of Health of Berlin, was quickly stamped out, was due to importation of the infectious principle from France, although this has never been definitely established, and from France a few points on the northern coast of Africa became slightly affected.

From Italy the cholera was carried into the Austro-Hungarian empire where it fell most heavily upon Trieste and the surrounding country. Buda-Pesth also experienced a considerable epidemic and the disease spread among quite a number of Hungarian villages in more or less close communication with their capitol. But the disease did not extend greatly in that empire.

Cholera finally invaded South America after one or two futile attempts, notably in the case of the *Matteo Bruzzo*, and spread across the continent from ocean to ocean for the first time. The disease was carried to South America from Italy.

The cholera reached the United States, at last, during the early autumn of 1887, after this country had been threatened more or less seriously since the first appearance of the epidemic in the South of France in 1884. It had been feared that cholera might be brought to us with the hordes of immigrants reaching our shores during almost the whole of the persistence of the Mediterranean epidemic, either from France, Italy, Austria, Spain, or Cuba. It was finally brought to the port of New York from Italy, but owing to the fortunate circumstance of its arrival late in the year and its detection before the steamers were allowed to land their infected immigrants, the epidemic did not advance beyond the quarantine station in New York harbor.

At the same time that this great epidemic was thus embracing in its deadly folds nearly all of that part of the west in close maritime communication with the afflicted Mediterranean countries, its tendencies had also been extended to the far east, and had involved more or less extensively China, Japan, and Corea.

Thus it is seen that during this great epidemic the cholera has encircled the globe in its course. On the whole, however, it has been much less destructive than have the former great

visitations of this disease. Perhaps the chief explanation of the comparative mildness and lessened tendency of this epidemic to overrun Europe and North America is the fact that, notwithstanding the bad hygienic conditions of the European countries first invaded and the mismanagement of local and general authorities, the advance of the epidemic beyond the localities actually attacked was far more vigorously and intelligently opposed than ever before. Possibly, also, something was owing to improvement in the general condition of the populations; for however slight this may have been it doubtless exercised a certain beneficial influence. The comparatively lessened tendency of this epidemic to seriously involve, as in former times, every country that was threatened, was assuredly not due to lack of essential malignancy of the cholera poison. The destructiveness of the epidemic in certain cities in Egypt, Italy, and Spain—as, for example, Dannetta, Naples, and Malaga—amply proves the energy of the infective principle of this visitation of cholera when conditions were favorable for exuberant development of the seeds of the disease in those localities where they had effected a lodgment and where but little, if any, intelligent restraint was opposed to their germination.

The experience gained by this last wide-spread wandering forth of cholera from India indicates very clearly to my mind an important fact which I think has been as a rule either ignored or has not been given its proper prominence. I refer to the very great influence which quarantines, both land and maritime; isolation and observation of suspects; disinfection of the personal effects of travelers—lax, imperfect, and frequently ridiculous, as they admittedly have been—have certainly exercised in markedly restraining—sometimes even arresting—the course of the epidemic. It is freely admitted that oftentimes, possibly even in the majority of cases, such restrictive measures fail to absolutely protect a given locality. But those who, because of this, would go to the extreme of abandoning all such barriers, totally ignore the vast importance of decidedly *retarding* the advance of cholera, even after it has passed the frontier and gained a decided foothold. That such restrictive measures do accomplish this very important result, there is to my mind the strongest testimony to substantiate. The tendency of the day, under the pressure of certain influences which will be spoken of hereafter, to throw the gates wide open to this unwelcome intruder from the Ganges, and trust wholly to good hygiene for protection against its baleful presence, is to my mind irrational and dangerous. From what has been said of the miserable hygiene of Egypt, France, Italy, and Spain, it is plain that those countries certainly have no claim for reliance upon such a means of protection.

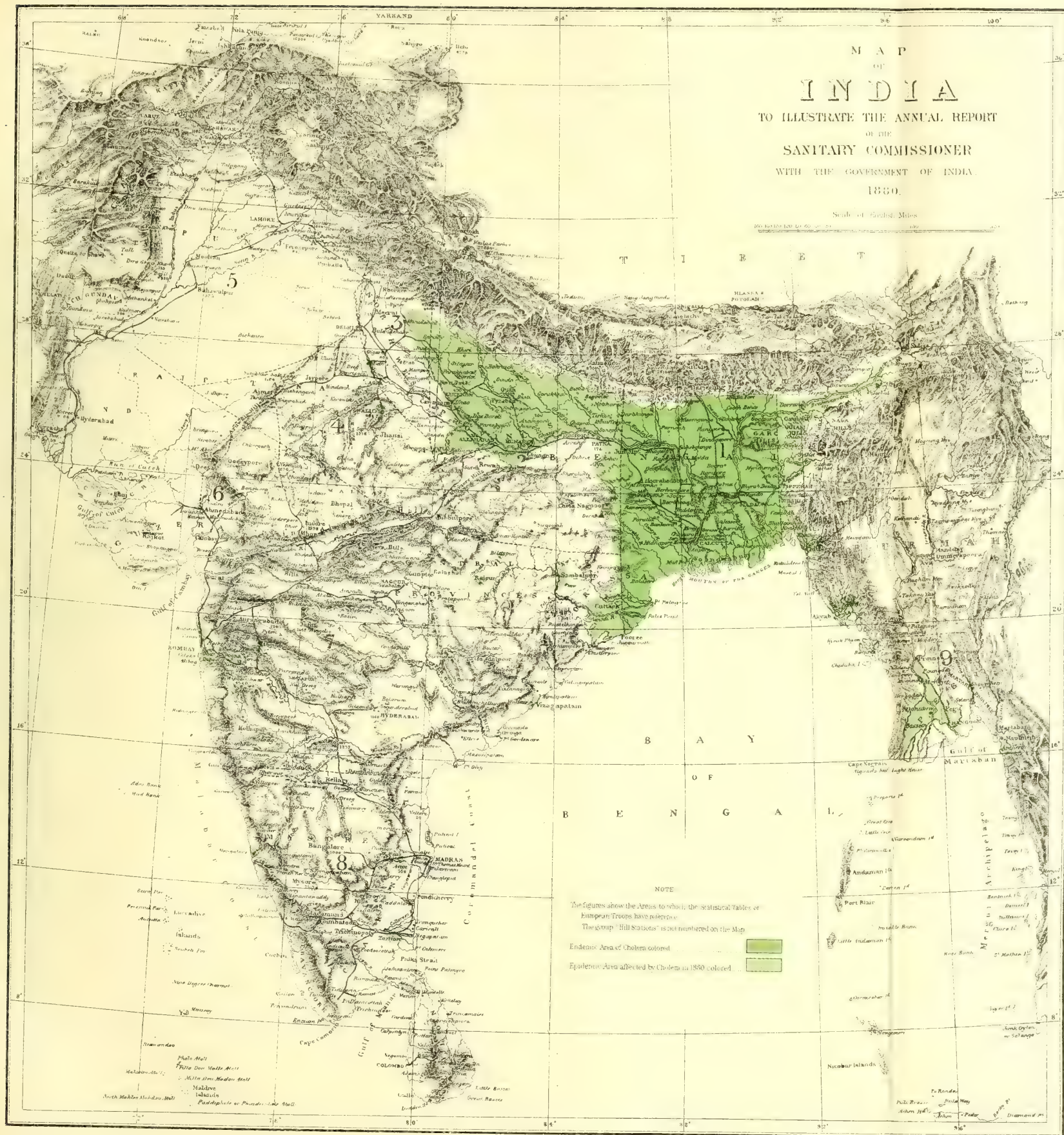
It is doubtful if even England, where \$300,000,000 have been spent in a single decade for the hygienic improvement of her towns and villages, could safely rely upon such a protection against the spread of cholera within her limits. Assuredly the United States of America, where, as a rule, the hygienic laws and organizations are very crude and insufficient, could ill afford at the present time to trust her safely to such idealistic means of protection. For any country to trust entirely to hygiene as a protection against the invasion and spread of Asiatic cholera when it is seriously threatened, while her hygienic condition is not fairly perfect, is, in my opinion, to commit the folly of inviting destruction. I postpone, however, the full discussion of this very important question until it shall be reached in regular order in Chapter VII of this report.

One thing in the foregoing accounts of the hygiene and demography of the several countries afflicted by the last epidemic of Asiatic cholera is prominent, namely, the monotonous recurrence of descriptions of miserable public and private hygiene, revolting contaminations of the drinking water, utter negligence in the disposal of excrementitious material. In these respects the conditions of the Province of Bengal, which is the endemic home and starting point of all epidemics of cholera which have from time to time spread over the world, and of other provinces in India which have periodically experienced visitations of cholera, are at one with those countries which have more or less suffered. Pursuing the course of allowing the people concerned to bear witness themselves in their own exposures, I deem it desirable to follow the foregoing with the testimony of East Indian officials concerning the abominable hygienic surroundings of the inhabitants of India, where hundreds of thousands are annually destroyed by cholera, and whence the whole world is almost constantly threatened with incalculable damage through the movements of trade, of armies, and of religious fanatics.



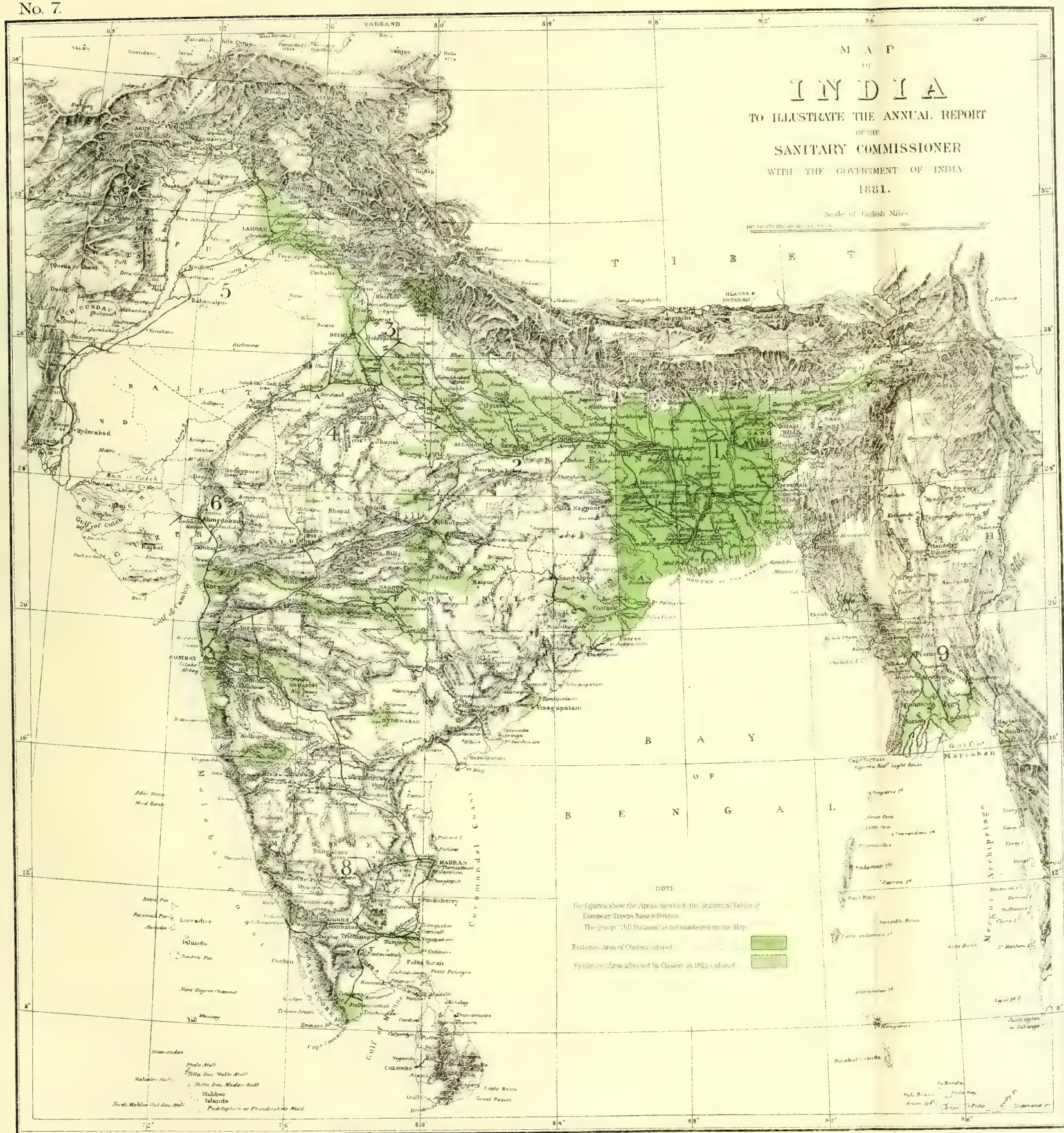
## ILLUSTRATIONS Nos. 6, 7, 8, 9, 10.

Maps of Hindostan, showing the relative prevalence of cholera from year to year (1880-'85), as also the endemic area of the disease.



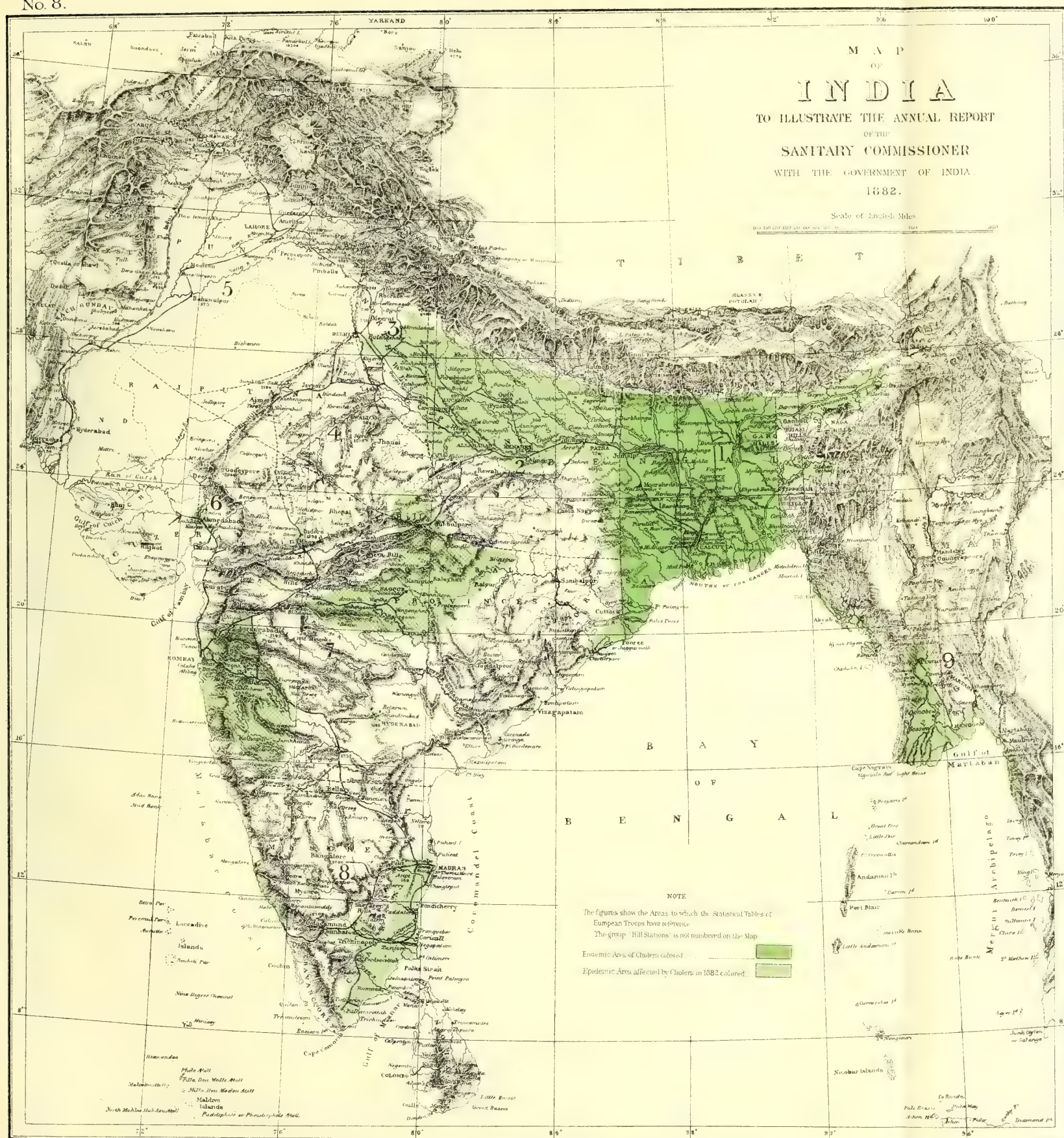




























## CHAPTER II.

### TOPOGRAPHY AND DEMOGRAPHY OF BRITISH EAST INDIA IN RELATION TO CHOLERA.

#### SECTION I.

##### PHYSICAL GEOGRAPHY OF HINDOSTAN AND BURMAH.

By general consent among the various authorities upon cholera, it appears that there is a certain area bounded by more or less indefinite limits where cholera is always endemic in India. This area may be said to correspond more or less closely with the bounds of the presidency of Bengal. This is comprised between the base of the Himalayas on the north and the Bay of Bengal on the south, the northwestern and central provinces on the west, China and northern Burmah on the east; and within the southern portion of it is located the delta of the united waters of the Ganges and the Brahmaputra, and in the northwestern portions are found the converging valleys of the Brahmaputra and the Ganges. Within this area, in Lower Bengal, that is, the country included within the delta and some of the adjacent districts, cholera is most constantly endemic. In the upper portion of the Presidency, that in which the valleys of these two rivers are located, the endemic character of the cholera is far less marked, and near the base of the Himalayas it is entirely lost, this portion of the province being usually affected only by epidemics which at longer or shorter periods spread over the country. The physical geography of Lower Bengal is very well described by the following abstracts from the Indian Gazetteer of Hunter (taken mainly from Bellew's History of Cholera in India) which more particularly refer to the southwestern district of Lower Bengal, but which very fairly indicate physical conditions found in the whole of the delta. It may be interesting also in connection with the description of the physical condition belonging properly to the endemic area of cholera to introduce also descriptions (from the same sources) of those which are found present in some of the other provinces of India, which are more or less frequently ravaged by epidemic cholera, and with them also some references to the habits of the people, which throw some light upon and more or less closely relate to the spread of epidemic diseases among them.

##### PROVINCE OF ASSAM.

*Geographical position and physical geography.*—Regarding the physical geography of Assam, the following account is taken from the sanitary report for 1877 by Dr. De Renzy, the sanitary commissioner for the Assam Province:

The province of Assam comprises Assam proper, or the valley of the Brahmaputra, on the north; the extensive districts of Sylhet and Cachar, or the valley of the Surma River, on the south; and the hill tracts of the Naga, Garo, Jaintia, and Khasi Hills which, intervening, separate the two river valleys. The hill tracts lying between them have a very small population, and, so far as sanitary matters are concerned, are under British control to only a very small extent. These hill tracts therefore are left out of consideration in the following history of cholera in this province:



The valley of the Brahmaputra is of a horse-shoe shape, about 450 miles long, with an average width of about 50 miles. It is open towards the west, and closed in on the other sides by lofty mountains. The river Brahmaputra flows through its whole length from east to west, receiving countless tributary streams, which carry the drainage of the mountains bordering on either side. The low lying tract in the vicinity of the river is subject to inundation to a distance of about 6 miles on either side of the stream. The valley is studded with numerous low conical hills or flat-topped mounds of considerable extent. These mounds or plateaux are the favorite sites for tea-culture; the low ground intervening between the plateaux is swampy, and suitable only for rice cultivation. "About one-fourth of the whole valley is subject to inundation every year, and a large portion of the remainder is in a semi-marshy state. About one-seventh of the area is under cultivation, tea or rice, and at least five-sevenths are a dense, impenetrable jungle, tenanted only by tigers, elephants, rhinoceros, and other wild animals."

The valley of the Surma consists of two portions, which differ greatly in their physical features. "The western portion comprises the district of Sylhet, and is for the most part a large alluvial plain, averaging some 70 miles in width, with clusters of low sandy hillocks scattered here and there. It is traversed by numerous streams and water-courses, whose banks are in many cases somewhat more elevated than the surrounding country. During the rainy months, that is, from June to October, the whole of the district, with the exception of the hillocks and the villages built on the elevated banks of the rivers, or artificially raised, is submerged, and communication between villages is effected by water mostly. The eastern portion of the valley comprises the district of Cachar, and consists of low, detached spurs, offshoots from the great Himalayan mountain chains; and between the spurs lie rich alluvial valleys, which are to a great extent under water during the rains. Rather more than half the area of Sylhet and one-twentieth of that of Cachar are under cultivation."

The rain-fall of the province is very heavy, and that at Cherapunji, on the southern face of the Khasi Hills, where, it is stated, it ranges from 450 to 700 inches in the year, is believed to be the heaviest in the world. The mean temperature, mean humidity, and rain-fall of the meteorological registering stations are given as follows. The average meteorological elements of England for the twenty-five years ending 1873 are added as a standard for comparison:

Stations.	Mean temperature.	Mean humidity.	Rain-fall, 1877.
Goalpara (9 years) .....	74.9	73.0	79.86
Sibsagar (4 years) .....	72.7	82.0	92.66
Cachar (8 years) .....	75.7	75.0	128.13
England .....	49.4	58.0	24.00

Vegetation in the Assam province generally is exuberant; there is a large amount of rice and jute cultivation, and extensive tracts are covered by swamps and uncultivated lands, which "render the climate essentially malarious."

The following is taken from the description of the station of Sylhet by Dr. Matthew, the civil surgeon, and regarding which the sanitary commissioner, Dr. De Renzy, says that, with slight modifications, it would hold good for most of the stations in the province:

The town limits comprise two distinct regions—the cleared and the uncleared. The cleared portion is a tract along the banks of the river, about 2 miles long, and varying in breadth from a few yards at the western end to a fifth of a mile at the eastern. The latter, the broadest part of the strip, is occupied from east to west by the principal bazars, the courts, and European residences. The space allotted to the courts and European houses is open ground, intersected by roads, and containing so many tanks that it would scarcely be an exaggeration to say that it consists of more water than solid ground. Westward the clear open narrows to a breadth little more than that of a road. Here is another bazar, a few houses formerly occupied by Europeans, all more or less dilapidated, and the houses of some boat-builders and other native artisans on the banks of the river. The uncleared portion of the town, where the majority of

the people live, lies directly behind, that is, to the north of the cleared portion, and may be roughly taken as being the same length from east to west, with an average width or depth of 2 miles from the bank of the river to the town limits on the northern side. Over this extent are spread the numerous mohallahs of the town, all more or less enveloped in dense vegetation, so much so that if it were not for the temples and houses of brick-work of former days one meets here and there, he would fancy that he was looking at a virgin forest, into which the inhabitants had recently ventured. From the roadside a thatched roof or two, peeping through the bamboo clumps, is perhaps all that can be seen, but this may be one of forty or fifty houses half buried in jungle. The stagnation of air, the want of sunlight, the constant damp—what this condition of dwelling represents may be easily imagined. But there is worse than this. Almost every house has a water-hole (rising to the dimensions of a small tank near the bazar and older houses), the contents of which are too often foul water and weeds; and round and through most of the mohallahs is a chain of ditches and water-courses, intended, no doubt, to drain the ground on which the houses stand; but from want of an outlet or proper incline these ditches are full to overflowing in the wet season, and at other times are choked with filth and decayed vegetation. The nearest cover represents the conservancy for the lower class, and though most of the better class of houses have privies of some kind, I am by no means certain that the primitive out-of-door arrangement is not less mischievous than such accumulations as most privies contain. The uncleared portion, as I describe it, of the town of Sylhet is not, it will be understood, all jungle. Breaks, occupied by tanks, marshes, or bits of cultivation, occur here and there, and occasional houses are outside the thickets, and stand on the sides of the roads; but certainly the general effect is, that the inhabitants have scooped out of the jungle a clear space just big enough for their houses, and afterwards encouraged the vegetation to close around them as thickly as possible.

Many of the villages in this district, if not nearly all of them, are in a most insanitary state. They are planted in the midst of jungle and a dense growth of bamboos; they are excluded from the sun or breeze, and for the first foot or two the soil consists almost entirely of animal excreta; there is no drainage, and they are flooded more or less for one-half the year, and are exceedingly damp and unwholesome the other half." (Report of sanitary commissioner of Assam, 1883.)

In order to discover whether the cholera that prevailed in Assam during 1869 could be traced to infection spread by imported laborers disembarked from steamers on board which the disease had prevailed, the chief commissioner of the province made special inquiry into the subject, the result of which went to prove that the appearance and spread of cholera in Assam are often, if not always, independent of importation by laborers from Bengal. In reporting on this subject, it is remarked by the deputy commissioner of Kamrup "that there was an almost annual visitation of cholera to Assam in the months of April and May, before the importation of coolies was ever commenced. He also notices the fact that although the disease had been supposed to be more severe in the neighborhood of Nowgong than elsewhere, yet no trading steamers ever touched there. Epidemics occur, it is stated, only at particular seasons of the year, although very few of the steamers carrying coolies are ever free from cholera. (From Bellew's, *History of Cholera in India*.)

Whether it is from the absence of roads and those currents of traffic along roads to which cholera appears to cling, or from the annual submersion of large tracts of country by which the district of Sylhet is practically converted into an archipelago, epidemic cholera is rarely heard of. Looking back to my notes on this point for the last six years, I find, says the civil surgeon, it has invariably happened that as soon as the country becomes dry cholera makes its appearance and remains until the inundations set in. With the dry season come reports of cholera from every direction. They are almost simultaneous from every point of the compass. It springs up like a plant of the season. Its progress can not be mapped out and traced from place to place like a cholera epidemic in the northwestern provinces. As soon as the rains have set in cholera as a rule disappears, or all but disappears. Unless, then, we suppose that a general combination has existed over a series of years among the chaukid-



ars to report cholera mortality in the dry season only, it may be safely concluded that the endemic cholera of Sylhet is a disease of the dry season only. (Annual Report of the Hist. of epidemic cholera in the district of Sylhet, Assam, by the civil surgeon, 1881.)

#### BENGAL PROVINCE.

*Geographical position.*—The Bengal Province is the largest and most populous of the provincial governments of British India, and yields a gross revenue of about one-third of the aggregate revenues of the Indian Empire. The Bengal Province is bounded on the north by Assam, Bhutan, and Nepal; on the east by the unexplored mountainous region which separates it from China and Northern Burmah; on the south by Burmah, the Bay of Bengal and Madras; and on the west by an imaginary line running between it and the adjoining local government of the Northwestern Provinces, and by the plateau of the Central Provinces.

Of the four great divisions of the Bengal Province, Bengal proper, Behar, and Orissa consist of great river valleys, while the fourth, Chota Nagpore, is a mountainous region which separates them from the Central India plateau. Orissa embraces the rich delta of the Mahanadi and the neighboring rivers, bounded by the Bay of Bengal on the southeast, and walled in on the northwest by tributary Hill States. Proceeding eastward, Bengal proper stretches along the coast from Orissa to British Burmah, and inland from the sea-board to the Himalayas; its southern portion is formed by the united deltas of the Ganges and Brahmaputra; its northern portion consists of the valleys of these great rivers and their tributaries. Behar lies on the northwest of Bengal proper, and comprises the higher valley of the Ganges, from the spot where it issues from the territory of the Northwestern Provinces. Between Behar and Orissa, but stretching farther westward and deep into the Hill country lies the Chota Nagpore territory.

*Physical aspects.*—The territory thus hemmed in, except at its northwestern angle, by the unchangeable land-marks of nature consists chiefly of two broad valleys. By the western one the Ganges brings down the wealth and accumulated waters of Northern India. By the eastern valley, the Brahmaputra, after draining the Tibetan plateau far to the north of the Himalayas, and skirting round their passes not far from the Yang-tse-Kiang and the great river of Cambodia, ends its tortuous journey of 1,800 miles. These valleys, although for the most part luxuriant alluvial plains, are diversified by spurs and peaks thrown out from the great mountain systems which wall them in on the north, east, and southwest. They yield in abundance every vegetable product which feeds and clothes a people, and enables it to trade with foreign nations. The soil is equally varied. The districts near the sea consist entirely of alluvial formations; and, indeed, it is stated that no substance so coarse as gravel occurs throughout the delta, or in the heart of the province within 300 miles of the river-mouth. But amid the hilly spurs and undulations on either side coal and iron and copper ores abound.

*Climate.*—The climate varies from the snowy regions of the Himalayas to the tropical vapor-bath of the delta and the burning winds of Behar. The ordinary range of the thermometer on the plains is from about 52° F., in the coldest month to 103° in the shade in the summer; anything below 60° F. is considered very cold. The rain-fall also varies greatly—from 500 to 600 inches per annum in Cherrapunji in Assam, to an average of about 37 inches in Behar and about 65 inches on the delta.

*Orissa.*—This division comprises the districts of Cuttack, Balsore, Pooree, and the Hill States. It forms the extreme southwestern portion of the Bengal Province, and is bounded on the north and northeast by Chota Nagpore and Bengal proper, on the east and southeast by the Bay of Bengal, on the south by Madras, and on the west by the Central Provinces. Orissa consists of two distinct territories—a fertile alluvial delta, comprising the three British districts of Cuttack, Balsore, and Poori; bounded on the east and south by the sea, and on the west and north by a wild region of sparsely populated tributary Hill States, which walls it out from the Central Indian plateau. The Orissa delta is formed from the deposits of the three great rivers—the Mahanadi in the south, the Brahmani in the center, and the Baitarani in the north. The three rivers gradually converge towards the coast, and dash down their accu-

mulated waters, within 30 miles of each other, upon Orissa. During summer their upper channels in the interior-table land dwindle to insignificant streams, dotted here and there by stagnant almond-shaped pools. Including two other minor streams—the Salandi and the Subanreka—they represent the accumulated drainage of 63,350 square miles, which during the height of hot weather only amounts to a discharge of 1,690 cubic feet per second. The average cold weather discharge is, however, 5,360 cubic feet per second; but during the rains the rivers rise till they bring down an aggregate of 2,760,000 cubic feet in time of flood. This enormous mass of water falls suddenly upon a narrow level strip of country. The river beds are altogether inadequate to carry off the flood. Thus, while the Mahanadi alone pours down 1,800,000 cubic feet per second in the height of the rains, the whole of its distributaries in the Orissa delta can only discharge 897,449 cubic feet per second. It follows, therefore, that only one-half of the waters thus brought down find an outlet through the deltaic distributaries to the sea. The other half bursts over the banks and sweeps across the country. As pointed out by Dr. Hunter, in his *Orissa*, "The Mahanadi illustrates in a striking manner the biography of a great Indian river. Rising in Central India, 520 miles off, it collects the rain-fall of 45,000 square miles, and pours down on the Orissa delta through a narrow gorge just above Cuttack City. In its first stage it runs on a lower level than the surrounding country, winding through mountain passes, and skirting the base of hills. During this long part of its career it receives innumerable tributaries from the higher country on both banks. So far it answers to our common English idea of a river. But no sooner does it reach the delta than its whole life changes. Instead of running along the lowest ground, it found itself hoisted up on its own deposits of silt, its banks gradually forming ridges, which rise above the adjacent country. Instead of receiving affluents, it shoots forth distributaries. The silt gradually accumulates in the bed and on its margins until its channel shallows, and its capacity as an outlet for the waters which pour into it from above diminishes. The same process goes on in every one of the hundred distributaries into which the parent stream breaks up; and as the beds grow more shallow their total discharging power becomes less and less adequate to carry off the water supply to the sea. As the rivers in the delta thus gradually build themselves up into high-level canals, so the lowest levels lie about half-way between each set of their distributaries. The country, in fact, slopes gently downward from the river banks, and in time of flood the overflow is unable to make its way back again into the rivers. The waters stand deep upon the harvest fields long after the main channels have run down. They slowly search out the lines of drainage, accumulating in stagnant swamps, drowning the crops, and poisoning the air with malaria, until they dry up or at last reach the sea. Even in periods of quiescence the rivers form a complicated net-work of channels, which crawl eastward by innumerable bifurcations, interlacings, and temporary rejunctions and divergencies." Besides its copious water supply, Orissa has a local rain-fall of  $62\frac{1}{2}$  inches per annum. Nevertheless the uncontrolled state of the water supply has subjected the country from time immemorial to droughts no less than to inundations. [Hunter's *Imperial Gazetteer*.]

The tributary Hill States of Orissa, nineteen in number, which form the mountainous back ground of this division of the Bengal Province, occupy a succession of ranges rolling backwards towards Central India. They furnish no cholera statistics, and therefore require no further notice here. [From *History of Cholera in India*, by Bellew. London, 1885.]

*Food supply.*—Regarding food supply it is stated that in Bengal rice boiled in water forms the principal article of diet of the people, and in many cases the only food taken.

Dal, fish, and vegetables are added to give relish and flavor to it. The ordinary daily allowance of rice for a healthy man is 12 chittaks or  $1\frac{1}{2}$  pounds. Boatmen and others often consume 14 chittaks. Wheat is not generally used by Bengalese except in sweetmeats. The Mohammedans in the towns consume fermented bread prepared by professional bakers. Various kinds of cake and biscuits are sold. Natives of Hindoostan generally fall into the habits of the Bengalese, and make rice the chief article of their diet. Those, however, who can afford it cook chappatis or unfermented bread. Mohammedans eat all sorts of meat with the exception of swine. Hindoos eat animal food very sparingly. Goat's flesh can be eaten, also



pigeons, ducks, and their eggs without losing caste. The poor often eat turtle also. About 2 chittaks of dal form an ingredient of almost every meal. The poor, being unable to buy dal and fish on one day, generally take them alternately. Milk, simply boiled or acidulated (dahi), is much used. Butter is not esteemed. Ghi (boiled or clarified butter) is universally employed in cooking vegetables and dal, which are eaten with the rice. Sweetmeats are always fried in ghi. Rice and milk, with sugar (parmanum) and spices added, is considered a great delicacy, and forms the last dish of the meal. This, however, is only partaken of on rare occasions. Native vegetables are generally cooked with ghi, mustard oil, or a mixture of it, and til (sessamum) oil, salt, capsicum, acid fruits, nim leaves, etc. Every native adds about 6 drams of salt to his meal. The poorer classes add a 'mixture' consisting of turmeric, laurel leaf, chillies, cummin, occasionally onion, garlic, and coriander. Garlic and coriander enter into the composition of the seasoning.

Fish of endless variety are sold in the bazaars. They are cheapest during the cold season; scarce and expensive during the rains.

Fish are generally fried in oil with salt, turmeric, and spices, and are eaten along with rice and vegetables. The mango is held in the highest estimation during the season. No meal is considered complete without it. Kathal, or jack-fruit, is the next in popularity. It is eaten raw or its juice is mixed with milk and drank in the hot weather. The cocoa-nut is much prized. The date is small and tasteless; from its juice, however, molasses is made. Bael is chiefly used in the form of sherbet. Plantains are highly valued, and are a favorite viand. The sour palms of the ber (*Zizyphus jujuba*) are much sought after by the poorer classes. Oranges and sweet limes are imported from Sylhet, and are largely consumed. In July pine-apples sell as cheap as two for 1 pice. Papaya, guava, cucumber, water-melon, etc., find a ready sale. The singcara nuts (water-caltrops), though less common than in Hindoostan, sell here at 2 lice a ser. Large quantities are sold towards the beginning of the cold season. (From the report of Dr. Wise, civil surgeon of Dacca.)

*Disposal of dead.*—In Dacca, within municipal boundaries, there are fifty-six recognized Mohammedan burial-grounds. The majority are in the outskirts of the town and in the jungly tracts bounding the north and northwestern suburbs; others, however, are situated in the center of the densely inhabited places. Throughout the district generally the dead are buried in the first piece of waste ground in the neighborhood of the village. The Hindoo dead are burnt on the banks of some stream or water-course. When the deceased is a beggar and has no friends, the mouth is touched with fire, two ghurras, filled with earth, are fastened one round the neck, the other around the loins, and the body is thrown into the river. A bamboo pole is driven through the belly into the bed of the river, so as to prevent its floating away. Where the river has lofty banks, the public ghats are selected as the fittest resting place for corpses. The living, however, have no scruples in drawing water from the vicinity. (From report of Dr. J. Wise, civil surgeon, Dacca, 1868, abstracted from History of Cholera in India, by Ballew. London, 1885.)

#### BERAR PROVINCE.

*Geographical position.*—The Berar Province is bounded on the north and east by the Central Provinces, on the south by the Nyzam's dominions, and on the west by the Bombay Province.

*Physical aspects.*—Berar is in the main a broad valley running east and west, lying between the Satpoora range on the north and the Ajanta range on the south. The valley at the base of the Satpoora is locally called Berar Payanghat, and the tracts situated among the uplands and hills of the Ajanta range, Berar Balaghat. Berar is watered or drained, as the case may be, by the Purna, an affluent of the Tapti River, and a perfect net-work of streams descending into the main river from the hills on either side on the north and on the south. The soil of the valley is one vast superstratum of black loam overlying trap and basalt, and its area is now entirely cultivated, the whole surface being covered over at harvest-time by

a sheet of crops. The rain-fall of the province is regular and copious. The valley is traversed in its whole length from west to east by the railway from Bombay to Nagpoor. It possesses one of the richest and most extensive cotton-fields in India, and produces excellent crops of millet and oil-seeds.

The length of the province from east to west is 150 miles, and its breadth averages 144 miles. The principal rivers are the Purna, the Tapti, the Wardha, and the Peganga or Pean-hita. There is but one natural lake in the province, the salt lake of Lonar, a great curiosity. The forests of the province are composed chiefly of the *Acacia Arabica*; about 400 square miles of forest on the Gawilgarh Hills and about 246 square miles of forest in South Berar are conserved by the Government.

*Climate.*—The climate of Berar differs very little from that of the Deccan generally, except that of the Payanghat Valley the hot weather is sometimes exceptionally severe. It sets in early, for the freshness of the short cold season disappears with the crops, when the ground has been laid bare by carrying the harvest; but the heat does not much increase until the end of March. From the 1st of May until the rains set in, about the middle of June, the sun is very powerful, though its effect is not intensified by the scorching winds of Upper India. The nights are comparatively cool throughout, probably because the direct rays of the sun are counteracted by the retentiveness of moisture peculiar to the black soil, and by the evaporation that is always going on. During the rains the air is moist and cool. In the Balaghat country, above the Ajanta Hills, the temperature is much lower than in the plains. On the loftiest Gawilgarh Hills the climate is always temperate; the sanitarium of Chikalda is on this range, a few miles from Ellichpur. (Hunter's Imperial Gazetteer.)

The Gawilgarh Hills are locally called Mailghat, and are not included in the area under mortuary registration. They are on the northern boundary of the province. The Ajanta range intersects the whole of the province from east to west, and divides it into the Hayanghat or "Lowland country," and the Banaghat or "Highland country." The Payanghat or valley of Berar lies between the Gawilghar and Ajanta Hills, and extends the whole length of the province from east to west, in which last direction it is bounded by the Khandesh district of Bombay. The valley is 40 to 50 miles in breadth, and varies in elevation from 800 to 1,400 feet above the sea. After the crops are cut the valley is by no means inviting. "What with want of shade and verdure and the scarcity of water, one can scarcely imagine a more depressing country to march through." The chief rivers are the Murna and the Wardha; the former with steep and soft banks and a bed of sand, or pebbles or rocks, forms the great drainage channel of the Payanghat; the latter, with high banks and a stony bed, forms the eastern boundary of the valley.

The Balaghat has an elevation above the sea-level varying about 900 to 2,200 feet, and the general declination of the land is toward the south, in which direction the river Penganga forms the boundary of the province, and constitutes the chief drainage channel of the Balaghat. The general aspect of the country here is quite different from that of the Payanghat, and is more enlivening. Trees are more plentiful, and water is nearer the surface; the surface soil is, for the most part, trap or trap with a light covering of black soil, and in the valleys rich alluvial. In the hot weather there is a great scarcity of water. (Berar Sanitary Report.)

#### BOMBAY PROVINCE.

*Geographical position.*—The Bombay Province is bounded on the north by the native state of Baluchistan, the Punjab Province and the native states of Rajputana; on the east by the Mahratta State of Indore, the Central Provinces, West Berar, and the dominions of the Nyzam of Haidarabad; on the south by the Madras Province and the native state of Mysore; on the west by the Arabian Sea, and on the northwest by Baluchistan.

*Physical aspects.*—The province presents on the map the appearance of an irregular strip of land stretching along the eastern shore of the Arabian Sea, and extending up the lower portion of the Indus valley. The continuous coast line is only broken towards the north by



the gulfs or Cambay and Cutch, between which lies the projecting peninsula of Kathiawar. The sea-board is generally rock-bound and difficult of access, though it contains many estuaries, forming fair-weather ports for vessels engaged in the coasting trade. Physically, Bombay may be roughly divided into two distinct portions, the Narbada forming the boundary line. To the north of that river lie Guzerat, Kathiawar, Cutch, and Sind; to the south the Mahratta country, including portions of the Deccan and the Karnatic, and the Konkan. The former of these tracts is for the most part a low plain of alluvial origin. In southern Guzerat the valleys of the Tapti and Narbada form sheets of unbroken cultivation, but in northern Guzerat the soil becomes sandy and the rain-fall is deficient. In Sind the surface is a wide expanse of desert sand, interrupted only by low cliffs or undulating sand-heaps. The geological formation is distinct from that of the rest of the Indian peninsula, consisting of limestone rocks, continuous with those found in Arabia and Persia. The latter of the two tracts is an upland country furrowed with high mountains and deep valleys, which intercept the rain-clouds of the monsoons and blossom with tropical verdure. The geological formation is composed of nearly horizontal strata of basalt and similar rocks, which naturally break up into steep terraces and hog-backed ridges, and have produced by their decomposition the famous "black-cotton soil," unsurpassed for its fertility. Within this second tract the Deccan, the Karnatic, and the Konkan are each marked by special features of their own. The Deccan, including Khandesh district, is an elevated plateau behind the Western Ghats. It is drained by several large rivers, along whose banks are fields of much fertility; but for the rest the air is dry and the rain-fall uncertain. The Karnatic, or country south of the Kistna River, is a plain of lower elevation, and contains wide expanses of black soil under continuous cultivation. The Konkan is the name of the narrow strip of land lying between the base of the Ghats and the sea. As a whole it is a rugged and difficult country, intersected by numerous creeks and abounding in isolated peaks and detached ranges of hills. The cultivation consists only of a few rich plots of rice-land and gardens of cocoanut. The rain-fall is excessive.

The outlying province of Sind is penetrated throughout its entire length from north to south by the Indus, whose overflowing waters are the sole means of distributing fertility throughout that parched region. Its season of flood begins in March and continues until September, during which time the discharge of water, calculated at 40,875 cubic feet per second in December, is said to increase tenfold. The entire lower portion of the delta is torn and furrowed by old channels of the river, for the surface is a light sand, easily swept away and redeposited year by year.

The most peculiar natural feature in the province is the Ran or Gulf of Cutch. It covers an estimated area of 8,000 square miles, forming the western boundary of the province of Guzerat; but when flooded during the rainy season it unites the two gulfs of Cutch and Cambay, and converts the peninsula of Cutch into an island. In the dry season the soil is impregnated with salt, the surface in some places being moist and marshy, and in others strewn with gravel and shingle like a dry river-bed or sea-beach. Considerable tracts of marshy land are to be found in the province of Sind, caused by the changes in the course of the Indus.

*Climate.*—The climate of Bombay Province presents great varieties. In its extreme dryness and heat, combined with the aridity of a sandy soil, Upper Sind resembles the deserts of Arabia. The thermometer here has been known to register 130° Fahr. in the shade. In Cutch and Guzerat the sultry heat, if not so excessive, is still very drying. Bombay Island itself, though in general cooled by the sea-breezes, is oppressively hot during May and October. The Konkan is hot and moist, the fall of rain during the monsoon sometimes reaching 300 inches. The table-land of the Deccan above the Ghats possesses an agreeable climate, as also does the South Mahratta country. The southwest monsoon generally breaks about the first week in June, and pours down torrents of rain along the coast; it lasts up to October. In Sind the monsoon rain exert little influence. During the rains, traveling everywhere except in Sind, is difficult and unpleasant. (Hunter's Gazetteer.)

The province of Bombay has an average breadth of about 350 miles, and a length of 1,000, while the coast line is 1,300. In so vast a territory, as might be expected, there are great

diversities of aspect, of climate, of condition. There are whole districts which are one large garden, and there are trackless wastes where the very absence of life is oppressive. There are places where the rain-fall may be marked by feet; there are others where cents would measure it. The people, too, are of many races and many creeds, and they present the extremes of contrast. There is met a kindness of which the most winning feature is its simplicity, and there is a heartless cruelty that makes one shudder. (Report of Sanitary Commissioner of Bombay.)

#### BURMAH PROVINCE.

*Geographical position.*—British Burmah is bounded on the north by Upper Burmah and Eastern Bengal, on the east by Karenni and the kingdom of Siam, and on the south and west by the sea. Including the Salween tracts and Northern Arakan, the population in 1876-'77 was estimated at 2,952,605, and the area in square miles at 88,556.

*Physical aspects.*—The province consists of a central portion—Pegu—which stretches inland for nearly 300 miles along the valley of the Irrawaddy River, and of two long strips of sea-coast—one on the north, Arakan, the other on the south, Tenasserim—each of which is shut off from the interior territory by a more or less continuous range of mountains.

Arakan, the most northern of the three divisions of the province, is a narrow sea-board strip, shut in on the east by the Arakan Yoma Mountains, and extending from the Naaf estuary in the north to the Khwa River in the south. Owing to the vicinity of the boundary range, its rivers are only inconsiderable streams. Of these the principal are the Naaf estuary; the Mru River, an arm of the sea running inland more than 50 miles, and from 3 to 4 miles broad at its mouth, and the Koladan or Arakan River, rising near the Blue Mountain, in latitude 23° north, with Akyab, the chief divisional town, situated on the right bank, close to its mouth. The Koladan is navigable for 40 miles from its mouth by vessels of 300 or 400 tons burthen. Farther south the coast is rugged and perilous for ships, but studded with fertile islands, the largest of which are Cheduba and Ramri. The Arakan Yoma range of mountains separates the division from Chittagong on the north and from Pegu on the south, and from Upper Burmah on the east.

Pegu, the central division of the province, is separated inland from the valley of the Salween—included in the Tenasserim division—by the Pegu Yoma range of mountains. The principal river in Pegu is the Irrawaddy. In the British territory its waters roll on in a south-southwest direction for 240 miles, when it empties itself by ten mouths into the sea. As it approaches the coast it divides itself into numerous branches, converting the lower portion of the valley into a net-work of tidal creeks. The other rivers in this division are the Hlaing or Rangoon, the Pegu, the Sittang, and the Bhileng, and there are some lesser streams. The Hlaing after passing Rangoon is joined by the Pegu and Puzundong Rivers. The two latter streams rise close together in the Yoma range, about 58 miles above the town of Pegu. They intercommunicate so frequently throughout the lower portion of the valley that they can hardly be pronounced distinct streams. The Rangoon River also communicates by more than one channel with the principal delta branch of the Irrawaddy. The Sittang River is joined by the Shwegyin River below the town of that name; it then gradually widens, and after a backward curve it issues through a funnel-shaped basin into the Gulf of Martaban, spreading so rapidly that it is difficult to distinguish where the river ends and the gulf begins. The Bhileng River enters the Gulf of Martaban between the Salween and the Sittang Rivers. The valley of the Irrawaddy and the Sittang unite towards their mouth to form an extensive plain, stretching from Cape Negrais to Martaban, the most productive portion of the whole province.

Tenasserim, the southern division of the province, has two principal rivers, the Salween and the Tenasserim. The former enters the sea at Moulmain, but owing to numerous rapids and rocks, it is navigable for only a few miles from that town. The latter flows past the town of Tenasserim, which gives its name both to the river and to the division, and enters the sea by two mouths, the northern channel being navigable for boats for about 100 miles.

The province is traversed from north to south by three chief ranges of hills. To the west is the Arakan Yoma, a cramped and stunted prolongation of the great multiple congeries



of mountains, which start from the Assam chain. Seven hundred miles from its origin in the Naga wilds it sinks into the sea by Cape Negrais. The Pegu Yoma is the range which separates the Sattang from the Irrawaddy Valley. At the head of the delta it branches out into several low terminal spurs, the extremity of one being crowned by the Cathedral of Buddhism, the great temple shrine of Shwe-Dagon. The Sittang and Salwin valleys are divided by the Pongloun range, a meridional chain, some of the peaks of which, in the neighborhood of Toungoo, reach an altitude of more than 6,000 feet. The Tennasserim Hills may be regarded as a prolongation of this range. They form the boundary between our territory and Siam.

The lakes in the province would be more properly entitled lagoons, and there are few of any importance. The best known is the Kan-daw-gyi, or Royal Lake, near Rangoon. The Thu Lake, in the Henzada district, is 9 miles round and  $2\frac{1}{2}$  across; and there are two lakes in the Bassein district, each about 5 miles in circumference. A canal connects the Pegu and Sittang rivers.

The country throughout the delta is flat and uninteresting. Toward Prome the valley of the Irrawaddy contracts, and the monotony of the plain is diversified by a wooded range of hills which cling to the western bank nearly all the way to the frontier. The Salwin Valley contains occasional harmonies of forest, crag, and mountain streams; but they bear the same relation to the sublimity of the Himalayas as the Trossachs to the Alps. On the other hand, the scenery in Tavoy and Mergui, and among the myriad islets which fringe the Tennasserim coast, is almost English in its verdure and repose. A large part of the province is covered with forests, most of them reserved by the state. The teak plantations lie in the Rangoon division.

*Climate.*—The climate of Burmah is moderate and equable. In 1876 meteorological observations were taken at thirteen stations in the province. The rainfall varied from a total of 230 inches in the year at Sandoway to 43 at Prome, the general average being about 130 inches. The great Indian rain-belt, stretching south from the Himalayas along the Bay of Bengal, includes all the sea-board and delta of the province, but the more inland stations are comparatively dry. The greatest heat is during March and April. It ranged from  $102^{\circ}$  Fahr. at 4 p. m., in the shade, at Thyetmyo, to  $85^{\circ}$  Fahr. at Akyab. The lowest minimum at 10 a. m., viz,  $53^{\circ}$  Fahr., occurred at Toungoo in January. The thermometric mean range is inconsiderable, varying from  $25^{\circ}$  at Thyetmo to  $14^{\circ}$  at Tavoy.

*Agriculture.*—Rice is the main crop raised in the province. In 1876 rice covered more than six-sevenths of the total area under cultivation—2,883,820 acres. It is sown in June, transplanted in September, and reaped about December or January. The Irrawaddy Valley furnishes about three-fifths of the rice produce of the country. The main river runs direct to a point about 80 miles from the sea, with lower stretches of land on either side intersected by tributary streams. The whole of this space is annually inundated, and it is scarcely exaggeration to state that an inch or so of water frequently determines whether the receding flood will leave a bright fruit-laden plain, or a sterile waste of ruined green. The Henzada and Bassein districts have been partially secured by an extensive series of embankments which fringe the right bank of the Irrawaddy and the left bank of the Ngawun River for nearly 200 miles.

#### CENTRAL PROVINCES.

*Geographical position.*—The Central Provinces comprise the territory lying between  $17^{\circ} 50'$  and  $24^{\circ} 27'$  N. latitude, and between  $76^{\circ}$  and  $85^{\circ} 15'$  E. longitude, and are nearly coincident with the old geographical division of Gondwana. The divisions, districts, area, and population are shown in the annexed tabular statement.

Besides the territory under British administration, there are sixteen native states included in the Central Provinces. Their aggregate area is 28,834 square miles, with an estimated population (in 1872) of 1,049,710 persons. Of these native states, that of Chutia Nagpur is the most extensive and important.

*Physical aspects.*—The tract falls naturally into several distinct areas, marked out by their physical features, and in a great measure by geological structure. To the north extends the Vindhyan table land (including the districts of Saugor and Damoh), which sheds its waters northwards into the valley of the Ganges. Throughout this region the surface is formed by the Vindhyan deposits, except in the large tracts where the Vindhyan strata are concealed by the overflowing volcanic rocks of the great Deccan trap area. South of Saugor and Damoh, in the valley of the Nerbudda, come Mandla (which includes the upper course of the river before it debouches into the plains), Jubbulpore, Narsinghpur, Hoshangabad, and a part of the Nimar, the rest of which lies in the valley of the Tapti. This area chiefly consists of alluvial and tertiary deposits, with a narrow belt of older rocks along the southern side of the valley. Continuing southwards, the next cluster of districts comprises Betul, Chhindwara, Seoni, and Balaghat, which occupy the extensive highlands constituting the table-land of Satpura, in great part formed of the Deccan traps, resting upon crystalline rocks, or upon sandstone and other rocks of later date. These districts at their central plateaus attain a height of about 2,000 feet. Still farther to the south extends the great Nagpur plain, formed by the valleys of the Wardha and Wain-Gunga, which comprises the districts of Nagpur, Wardha, Bhandara, and Chanda. This region has no great elevation. It rests principally upon gneissose and trap rocks, the former predominating in Nagpur and Bhandara, the latter in Wardha eastwards. Below the Ghats lies the Chhatisgarh plain, a low expanse of red soil, containing the districts of Raipur and Bilaspur. In this division is also included the district of Sambalpur, a rugged and jungly country, composed of crystalline and metamorphic rocks; this district is not a part of Chhatisgarh, either geographically or historically; it lies principally in the valley of the Mahanadi. Last of all, to the extreme south, almost cut off by forests and wild semi-independent states, is the Upper Godavari district, a strip of territory of varied geological structure, stretching along the left bank of the Godavira.

Thus a hill plateau is succeeded by a lowland plain, and again a larger and loftier plateau by a larger plain, ending in a mass of hill and forest, which is probably the wildest part of the whole Indian peninsula. But even the comparatively level portions of this area are broken by isolated peaks and straggling hill-ranges; and nowhere in India are the changes of soil and vegetation more rapid and marked than in the Nerbudda country. The Satpura plateau, stretching east and west for nearly 600 miles, with the wheat fields of the Nerbudda valley on the one hand and the rice lands of the Nagpur plain on the other, forms the true barrier between Northern and Southern India, and constitutes the country of Gondwana, the retreat of the aboriginal Gond people. (Hunter's Imperial Gazetteer.)

The native states included in the central provinces are very sparsely populated, and some of them intervene between the British districts, chiefly in the eastern division and in Chanda, and thus interfere with the general registration of vital statistics in the provinces. There are also considerable tracts of hill and forest in Hoshangabad, Nimar, and Chhindwara which are not reached by registration. Of the whole area of the provinces little more than one-fourth is under cultivation; the remainder is barren rock, waste, and forest. The population is generally very sparse.

The central provinces, within the limits above defined, present a great variety of physical aspects and climate. Their extreme length from north to south is 500 miles, and their breadth from east to west is 600 miles. To the east the provinces extend to within 100 miles of the Bay of Bengal; to the west they are bounded by Khandesh and Malwa, which separate them from the gulf of Cambay; to the north by the independent states of Bandelkhand, and by Bhopal; and to the south by the Nizam's dominions and the Madras provinces.

The province contains rich valleys and wide fertile plains, but taking it as a whole, it is a mountainous country. Some districts lie wholly among hills, and the surface of even the most open districts of the plains is more or less broken by low ranges and isolated hills. (From the History of Cholera in India. Bellew.)



## MADRAS PROVINCE.

*Geographical position.*—The Madras province occupies, with its dependencies, the entire south of the peninsula of India. Its extreme length from northeast to southwest is about 950 miles; its extreme breadth about 450 miles. The area and population of the territory under British administration are respectively, 138,318 square miles, and 30,749,401, or 226.2 inhabitants per square mile.

The five native states in political dependence on Madras, namely, Travancore, Cochin, Pudukottah, Banganapalli, and Sandhur, have an additional area of 9,818 square miles and 3,289,392 inhabitants. For these no statistics are available.

The province is washed by the open sea on every side but the north. On the east coast is the Bay of Bengal, the coast-line extending continuously from southwest to northeast for nearly 1,200 miles, from Cape Comorin to Chilka Lake. The western coast is formed by the shore of the Indian Ocean for about 540 miles. Off the southeast lies the Island of Ceylon, separated by a shallow strait, across which runs the string of rocks and sand-banks known as "Adam's Bridge." The irregular northern boundary of the province has been formed by accidents of history. On the extreme northeast is the Bengal province of Orissa; next comes the wild highlands of the central provinces; then for a long stretch the dominions of the Nizam of Haidarabad, separated by the Kistna River and its tributary, the Tungabhadara; lastly, on the northwest and west, the Bombay districts of Dharwar and North Kanara. The native state of Mysore occupies a large portion of the center of the area thus defined, and geographically forms a part of the Madras province.

*Physical aspects.*—Viewed on the map, Madras presents a very broken aspect. Its eastern coast extends up the peninsula more than twice as far as its western, whilst its heart seems to be eaten out by the intruding state of Mysore. From a physical point of view it may be roughly divided into three portions. (1) The long and broad eastern coast; (2) the shorter and narrower western coast; and (3) the high tableland in the interior. These divisions are determined by the two great mountain ranges of the Eastern and Western Ghats, which give the key to the configuration of all southern India. The Eastern Ghats, which lie entirely within this province, form a continuation of the confused hill system of Chhota Nagpur. They run in a southwesterly direction, almost through the entire length of Madras, until they lose themselves in the Nilgiris, and there join with the western range. Their average height is only 1,500 feet, and for the most part they have a broad expanse of low land between their base and the sea. Their line is pierced by three great rivers, the Godavari, Kistna, and Kaveri, as well as by minor streams, so that they do not perform the part of a water-shed. The Western Ghats, on the other hand, which stretch southwards continuously along the shore of the Indian Ocean from the north of Bombay, satisfy all the characteristics of a mountain range. Rising steeply at a distance of 30 to 50 miles in the Madras districts from the coast they catch almost the whole rain-fall of the monsoon, and in the south not a single stream breaks through their barrier. Some of their peaks attain an elevation of more than 5,000 feet. Between these two bordering ranges lies the central table-land, with an elevation of 1,000 to 3,000 feet, which includes the whole of Mysore, and extends over about half a dozen districts of Madras. Each of these three divisions has natural features of its own. The eastern coast possesses the deltas of the three great rivers, where artificial irrigation has combined with natural fertility to reward the toil of the husbandman. On the west coast the rain-fall never fails, but cultivation is hemmed in within narrow limits by the mountains and the sea. In the central plateau the country is generally bare, the rain-fall light, and the means of irrigation difficult, but it contains many tracts of fertile soil, and the cultivator does his best to store in tanks the local showers which the monsoons bring from either coast.

The three principal rivers of Madras are the Godavari, the Kistna, and the Kaveri, each with a large tributary system of its own. All of these rivers have the same uniform features. They rise in the Western Ghats and run right across the peninsula in a southeasterly direction into the Bay of Bengal. They drain rather than water the upper country through which they flow, and, like other rivers which fall into the Bay of Bengal, all of them spread over alluvial deltas before they reach the sea.

The Eastern and Western Ghats, already described, constitute the two main hill systems of the province. The Nilgiri, which join these two ranges, culminate in Dodabetta (8,640 feet), the loftiest peak in Southern India. There are, besides, many outlying spurs and tangled masses of hills, of which the Shevaroy's in Salem, the Annamallais in Coimbatore, and the Pulni Hills in Madura are the most important. South of the Palghat Gap, where the range is cut down to within 1,000 feet of the sea-level by a break 25 miles wide, the Western Ghats resume their course at full level right down to Cape Comorin, and immediately widen out into the highland tract that lies between Madura on the one side, and Malabar, Cochin, and Travancore on the other, known as the Annamallais in Coimbatore, and as the Pulnis in Madura. Toward the south this hill tract narrows, and behind Tinnevely becomes only a mountain range between the two coasts with a restricted area. On the western coast the perpetual antagonism between the mountain torrents and the ocean has produced a remarkable series of back waters or lagoons, which fringe the entire sea-board of Kanara, Malabar, and Travancore, and are used for inland navigation.

*Climate.*—The climate of Madras varies in the different parts of the province, being determined by the very diverse geographical conditions. The Nilgiri Hills enjoy the climate of the temperate zone, with a moderate rain-fall, and a thermometer rarely exceeding 80° Fahr., and sometimes falling to freezing point. On the Malabar coast the southwest monsoon brings in excessive rain-fall, reaching 150 inches in the year at certain spots. The rain clouds hanging on the slope of the Western Ghats sometimes obscure the sun for month after month. Along the eastern coast and on the central table-lands the rain-fall is comparatively low, but the heat of the summer months is excessive. The whole coast of the Bay of Bengal is liable to disastrous cyclones, which have repeatedly overwhelmed the low-lying ports. (From History of Cholera in India, Bellew, London, 1885.)

#### NORTHWESTERN PROVINCES AND OUDH.

*Geographical position.*—The Northwestern Provinces are bounded on the north by Tibet, on the northeast by Nepal and Oudh, on the east by Bengal, on the south by Chota Nagpore, Rewah, Bandelkhand, and the central provinces, and on the west by Gwalior, Rajputana, and Punjab. The Oudh province is bounded on the northeast by Nepal, on the northwest by the Rohilkhand division, on the southwest by the river Ganges, on the east by Basti district, and on the southeast by Benares division. The native states—Garwhal and Rampur—contain an area of 5,125 square miles, with a population of 657,013 persons.

*Physical aspects.*—The Northwestern Provinces and the province of Oudh together include the whole of the wide Gangetic basin from the Hanjab plain and Himalayas to the Vindhyan plateau and the low-lying rice fields of Bengal, the Oudh province occupying the large semi-circular tract comprised in the valleys of the Geogra and the Gumti, and intervening between the Rohilkhand and Benares divisions. The provinces taken as a whole consist of the richest wheat-bearing country in India. Irrigation is free both by the numerous rivers which issue from the northern mountains and artificially by a magnificent system of canals and distributaries, which owe their origin to British enterprise. The general surface presents a very monotonous alluvial plain, only merging into hilly or mountainous country at the extreme edges of the basin on the south and north. The country slopes from every side to the main stream of the Ganges in its course from the Himalayas, the Rajputana uplands, and the Vindhyan plateau to the bay of Bengal, and its alluvial soil is cut into deep channels by the numerous great rivers flowing down from the ring of heights on every quarter. The two principal rivers are the Jumna and the Ganges, which unite at Allahabad. The country inclosed between contains some of the most populous and fertile districts in the Northwestern Provinces, and is covered with a great ramification of irrigation canals, originally derived from the rivers on either side. These rivers flow through low-lying valleys, which are fertilized by their overflow or percolation. North of the Ganges, and closed in between that river and the Cumnaun and Garwhal Hills and Oudh, lies the plain of Rohilkhand. It presents the general level features of the Gangetic Valley, only slightly varied by the Tarai tract at the



foot of the hills. South of the Jumna the Bankelkhand country slopes up from the river bank to the edge of the Vindhyan plateau. It is a poor and irregular region, with a rocky and unfer-  
tile soil; it is intersected by native states, and the population is impoverished, scanty, and  
ignorant. The northern portion near the Jumna approximates in the character of its soil to  
the interfluvial plain of the opposite Doab, but the southern portion is much cut up by sand-  
stone and granite hills, emanating from the Vindhyan range. Below Allahabad the country  
approximates in appearance to the plains of Bengal, and in its northern part stretches across  
Oudh to the foot of the Nepal Himalayas. To the westward, south of the Ganges, the general  
features of the country somewhat resemble those of Bandelkhand; but the lowlands along the  
river bank are more fertile, while the hill country is more mountainous and of greater extent.  
The principal rivers in these provinces are the Ganges, the Jumna, the Gogra, the Gumti, the  
Chmabal, the Betwa, the Rapti, the Ramganga, etc., all of which drain directly or indirectly  
into the Ganges.

*Climate.*—The climate varies in the different parts of these provinces. Generally speaking,  
the northern part may be considered as hot and dry, and the southern, towards Benares and  
Bandelkhand, as more oppressive and somewhat moist. In Oudh the climate assimilates to  
that of Lower Bengal, but is less damp, though the heat is most oppressive in the rainy sea-  
son. The year naturally comprises three seasons—the cold, from October to February or  
March; the hot, from March to June; and the rainy, from the middle of June to the begin-  
ning of October. The rain-fall is very variable over the different divisions, being heaviest near  
the hills and lightest on the mid-plains. (Hunter's Gazetteer.)

#### PUNJAB PROVINCE.

*Geographical position.*—This province is bounded on the north by Kashmir and the hills  
of Swat, on the east by the Jumna River and the Northwestern Provinces and Thibet, on  
the south by Rajputana, the Sutlej River, and Sind, and on the west by the Suleman range,  
Balochistan, and Afghanistan. The native states dependent on the Punjab, thirty-five in  
number, in 1876-'77, had an estimated area of 114,739 square miles, with an estimated popula-  
tion of 5,410,389 persons, thus making the total area of the province 219,714 square miles,  
and its gross native population 23,021,887.

*Physical aspects.*—Extending from the river Jumna on the east to the foot of the Suleman  
range on the west, and from the outer Himalayas on the north to the desert of Rajputana  
and Sind on the south, the province comprises five well-defined tracts, viz, the Punjab proper,  
or country of "five rivers"—the confluent streams of the Sutlej, the Beas, the Rayi, the  
Chenab, and the Jhelam; the Sind Ságar Doáb, or country between the Jhelam and the Indus;  
the Deraját, or trans-Indus territory, between the Indus and the foot of the Suleman range;  
the Sirhind table-land between the Sutlej and the Jumna—the cis-Sutlej districts; and the  
Himalayan valleys of Kangra, Kulu, Lahaul, and Spiti, and the valleys of the Hazara  
frontier towards the Hindu Kush. The general slope of the country is from the snow-clad  
mountains bounding it on the north and east by a slight southwestward declivity towards the  
arid sandy plateau of Rajputana and Sind on the south and southwest. All its rivers, except  
the Jumna, bounding it on the east, follow the general slope of the land, and, joining the Indus  
low down its course, empty into the Indian Ocean by the outlet of that river. The great  
alluvial plain of the Punjab depends for its physical features entirely upon the action of the  
rivers by which it is thus traversed. Naturally the plain belongs to the same wide and level  
table-land as the deserts of Rajputana and Sind, and would, owing to the scanty precarious  
rain-fall of Northern India, present a similar arid and barren surface as those southern tracts  
were it not for the fertilizing influence of its great rivers. On the plain, after leaving the  
hills, the rivers flow each in a constantly changing central channel, occupying the middle  
or one side of a broader valley, whose limits are marked by high banks of clay, which bound  
the level plateau above. The river valleys themselves are irrigated by inundation, by per-  
colation, by wells, or by artificial canals; but the high immediate plain stretches from stream  
to stream in a broad and undulating expanse of sterile sand hills and stunted vegetation,

except where under canal or well irrigation. In these sterile tracts the well water is in many places from 50 to 120 or more feet below the surface, especially in the districts bordering on the Rajputana and Sind deserts on the south. Thus the cultivated and populated tracts lie along the course of the several rivers, while the sterile intermediate tracts are sparsely peopled and mainly used as pasture lands. As a rule, wood is scarce throughout the Punjab, except upon the hills and about the towns and villages. In the cis-Sutlej districts there are extensive mango groves, and in the Deraját large areas are covered with date palms. On the sterile tracts between the rivers the surface is generally covered with jungle scrub, principally composed of mimosa and zizyphus and coarse grasses. The climate of the plain country is noted for its dryness and heat. At the foot of the hills the rain-fall is comparatively high, but it diminishes towards the northwest of the province and on the plain in proportion with the distance from the hills, the southern districts on the borders of the Rajputana and Sind deserts being almost rainless. (Hunter's Imperial Gazetteer.)

S. Mis. 92—25



## ILLUSTRATION No. 11.

Map of Kidderpore and Alipore, a suburb of Calcutta, a reduction from the latest official map published by that city.

This map shows the relative area of the water-tanks and surrounding ground, the location and area of the water-tanks being represented in black.

This map is a fair example of the prevalence and extent, relative to the surrounding land, of the water-tanks throughout Calcutta, and it may be also be taken as a fair representation of the relative number and area of similar water-tanks so universally scattered through the towns and villages of the presidency of Bengal, and in fact in many of the other provinces of Hindoostan. These tanks, as a rule, serve the native population for drinking water, for the washing of clothes, for bathing, for domestic and culinary purposes, and in fact all others for which water is commonly used.

MAP OF KIDDERPORE & ALIPORE:

CALCUTTA PORT IMPROVEMENTS.











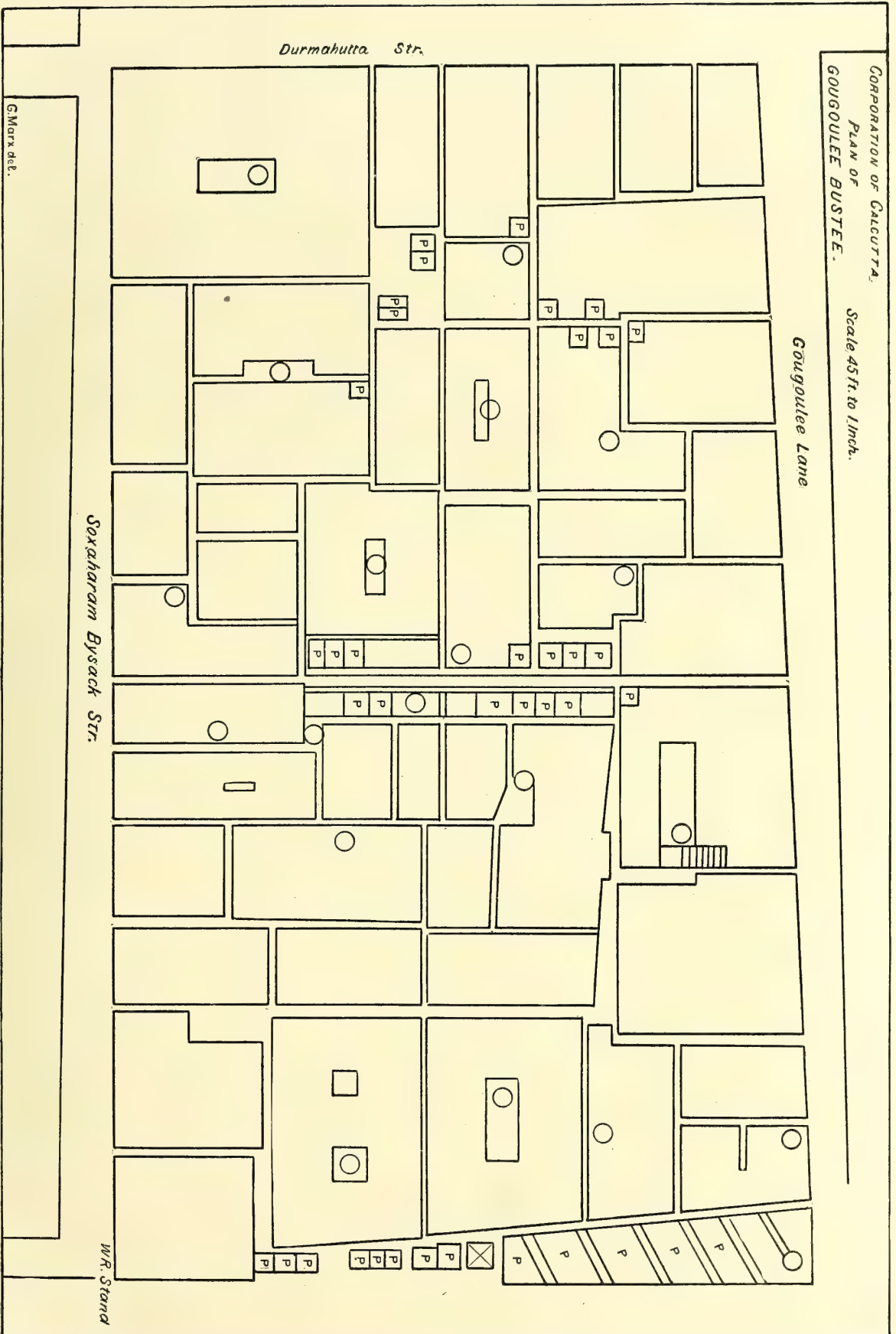
## ILLUSTRATION No. 12.

An accurate copy obtained from the corporation of Calcutta of an official plan of Gougoulee-bustee, a small section in one of the wards of Calcutta.

This plan shows the number, locality, and relations of the private water-wells and privies in the huts comprising this bustee. The circles representing the wells and the square blocks marked "P" representing the privies.

CORPORATION OF CALCUTTA.  
PLAN OF  
GUGGULEE BUSTEE.

Scale 45 ft. to 1 inch.











## ILLUSTRATIONS NOS. 13, 14.

Reproductions of photographs occurring in the official report of Dr. Simpson, the health officer of Calcutta, for the year 1886, illustrative of the miserable drainage and the dangerous relation of that to private wells existing throughout the native portion of the city of Calcutta, and which may be said also to be common in nearly every town and city in Hindoostan.

Numbers 13 and 14 show the same compound or interior court within a native dwelling, but from different points of view.

## DESCRIPTION OF DETAILS IN Nos. 13 AND 14.

1. Entrance to privy.
2. Drain covered with tiles leading from privy.
3. Continuation of drain No. 2.
4. A second drain covered with tiles, leading to gully-pit (sink).
5. Surface grating, taking off water from compound into gully-pit.
6. Gully-pit, close to well, and into which the several drains discharge, and which is connected with bustee under-ground drainage.
7. Well, surrounded by broken drains.

ILLUSTRATION No. 13.



ILLUSTRATION No. 14.







## SECTION 2.

## DEMOGRAPHY, DRAINAGE, WATER SUPPLY, MILK CONTAMINATION, CHOLERA, ETC.

*DIFFICULTIES OF VILLAGE SANITATION.*

## HOUSEHOLD OFFAL.

Being a native of the country the opinions of Dr. Ghose, of Rungpore, on the difficulties that stand in the way of village sanitation, possess some value. He says no sanitary rule is infringed more in India than that relating to conservancy. The Hindoo idea of cleanliness, dwindling into a superstition, regards the human excreta as something unholy and unfit to be touched except by a certain caste, the mehters. The people have therefore become perfectly helpless as regards the removal and proper disposal of their own excrement, and their habit of living together in large family-houses intensifies the evil. All the members of the household void their excrement in one place, and they would much rather breathe the effluvia from the decomposing mass than remove it themselves. In most places in Bengal the mehters, as a class, are independent and, taking advantage of the fewness of their number, set their own price on their services. The result is the people either resort to well privies or have the soil removed at long intervals, and, even when they do remove it, it is taken and thrown away behind a bush or in some low place in the midst of the jungle. Here it decomposes with vegetable matter, and, besides tainting the atmosphere, is washed during heavy rain, with all the vegetable and animal germs bred in it, into sources of drinking water. Thus what was unholy and unfit to touch indirectly enters, in a more pernicious form, into the lungs and stomach. The uneducated mind can not see the evil. Youths who will recite Shakespeare and Milton and quote Bentham and John Stuart Mill, are ignorant of the first principles of their existence, viz, that pure air and pure water are essential to the maintenance of life. Religious and social reformers can be found by the thousand who will propound and solve ethical problems and yet not see what questions of morality are involved in the infringement of the laws of hygiene. The education, therefore, of the people in the principles and practice of sanitation is the first remedy for the evil, and unless such education precedes the enactment of laws for the maintenance of public health, those who are intrusted with the administration of those laws will find it impossible to administer them. The opposition one meets with and the unpopularity one has to be prepared for when carrying out any sanitary scheme, is so great that even the most strong-minded man is thwarted in his efforts. The next difficulty in the carrying out of sanitary reforms is the expense that it entails as a rule. Much can no doubt be done by judiciously extending one measure over a number of years, but the frequent change in the personnel of the municipal authorities does not allow of such a course. One officer plans a certain improvement and leaves it partially executed. His successor, not seeing the importance of it, neglects to finish it, and the money already spent is wasted. (From Section IX. Sanitary Works, Annual Report of the Sanitary Commission for Bengal, 1879.)

## BUSTEES.

A bustee or native village generally consists of a mass of huts constructed without any plan or arrangement, without roads, without drains, ill-ventilated, and never cleaned. Most of the villages and towns are the abodes of misery, vice, and filth, and the nurseries of sickness and disease. In these bustees abound green and slimy stagnant ponds, full of putrid vegetable and animal matter in a state of decomposition, whose bubbling surfaces exhale, under a tropical sun, noxious gases, poisoning the atmosphere and spreading around disease and death.

These ponds supply the natives with water for domestic purposes, and are also the receptacles of their filth. The arteries which feed these tanks are the drains that ramify over the village, and carry out the sewage of the huts into them. Their position is marked by a development of rank vegetation.



The entrances to these villages are many, but not easily discoverable, whilst the paths are so narrow and tortuous that it is difficult for a stranger to find his way through them. The huts are huddled together in masses, and pushed to the very edge of the ponds, their projecting eaves of ten meeting together, whilst the intervening spaces, impervious to the rays of the sun, are converted into necessities, and used by both sexes in common. In these huts often live entire families, the members of a hut all occupying the single apartment of which it is not unfrequently composed, and in which they cook, eat, and sleep together, the wet and spongy floor, with a mat spread on it, serving as a bed for the whole.

The distinction of caste extends to these villages, but it assumes in these places a new form, by the fact that some portions of them, called parrahs, are inhabited by people of one occupation or trade, whose habits of living give a distinctive feature to each parrah, and modify its general appearance. Amongst the Hindoos, the worst and filthiest bustees are those occupied by Gowallahs (or dairymen), Coloos, Chumars, or Moochees. Amongst Mohamedans, the worst and filthiest villages are those occupied by Garrywans and Khallasees. In bustees occupied by dairymen, in addition to the usual filthy tank, the water of which is used by them to dilute the milk sold for public consumption, there are pools of liquid filth covering a large surface; the area of one of them I ascertain by actual measurement to be over 150,000 square feet.

None of these villages possess a single road or thoroughfare properly so called, through which a conservancy cart or even a wheelbarrow can pass in order to remove the filth. This filth is laid at the door of every hut, or thrown into a neighboring cess-pool. Not a single hut in the villages is properly built. The dwellings are badly constructed, crowded together without regard to ventilation or the means of being kept clean. The principal defects are due, not only to ignorance and utter disregard of all sanitary considerations by the ryots, but also to the apathy and negligence of the proprietors, who care very little about the welfare of their tenants provided that their rents are paid regularly.

In this description we have a faithful picture of the localities cholera delights in. Nor must we overlook the fact that it is the practice of the natives, rich and poor, to defecate upon the soil around their dwellings. Further, I may observe that I have never seen such a thing as a pump for domestic purposes in use in India; all the drinking water is drawn from large ponds or tanks, sometimes from open wells, being carried from thence to the vessels from which we drink, in leathern bags—the skins of sheep—having a hole in them once occupied by the neck of the animal; these bags can never be properly cleaned out, and they are often in constant use for several years. Now, considering the practice of the natives above referred to, and the constant heavy down-pour of rain we experience from time to time in India, it is easy to imagine how frequently the tanks and rivers containing the supply of drinking water must receive the surface drainage of the surrounding localities, and become contaminated with all manner of organic impurities.

*Drainage.*—Generally speaking, there is no regular system of drainage. The drains, wherever they exist, are mostly ditches in the sides of the streets for the escape of storm water. Cess-pools are common, and the drainage of houses empty into these or is allowed to flow into the back yards, to be absorbed into the soil.

*Conservancy.*—The same system would appear to be adopted in almost every circle. Small scavengering establishments are employed in some of the smaller towns and large villages near and around the divisional headquarters, who clean the streets and collect the sweepings, which are either buried or burned or periodically sold by auction as manure to the ryots. During the year under review, out of a total of 47,242 towns and villages *only* 639, *were so conserved*. This is but a very small proportion, and even in some of these the establishment employed is so small that the proper conservation of the villages can not be well attended to.

In some circles a larger number of towns and villages enjoy the luxury of a conservancy establishment than in others. Thus, in the Coimbatore district, 74 out of a total of 1,575 villages are so favored; in the Guntur Circle, 50 out of 874; in the Tinnevely Circle, 46 out of 1,339, and in each of the Tanjore and Madanapalli Circles, 43 out of 2,091 and 479

villages, respectively ; while in Canara only 2 villages out of a total of 1,290 are conserved ; in Malabar only 6 out of 432 ; in Penukondah only 7 out of 583 ; in Bellary and Vellore only 9 in each out of 1,266 and 1,350, respectively ; and in Chicacole and Hosur only 10 in each out of 2,192 and 2,294 villages. In the 18 other circles the numbers are between 10 and 35 out of an average of 1,702 villages and towns.

The towns and villages in which no such establishments exist, and which are so very numerous, are left to take care of themselves at the mercy of the rural population. These people can not be made to understand what filth and dirt mean, and are so ignorant of the rudiments of sanitation that they violate its fundamental law every day of their lives by polluting the water supply in every possible manner, by defiling village sites, waste lands, corners of by-lanes and streets, and tank-banks with human excrement, and by accumulating heaps of manure and other offensive and noxious matters injurious to public health in and around their dwellings. No wonder that the inspection notes of the towns and villages in the Presidency are, as a rule, but a constantly recurring complaint of bad conservancy and utter neglect of the simplest rules of sanitation.—(From Annual Report of Commissioner for Madras, 1881.)

#### CONSERVANCY IN CALCUTTA.

*Scavenging and removal of refuse.*—The allotted establishment of carts, coolies, etc., is counted every day by the overseers at their respective muster grounds and distributed to the work, which commences at earliest dawn. The refuse having been deposited on the streets by the occupants of houses, is removed in municipal carts to tanks that may be in course of filling, or to the nearest platform on the municipal railway. The small or “single” carts, each drawn by a single pony or bullock, are filled by their drivers, the large or “double” carts, drawn by a pair of buffaloes or bullocks, have additional coolies allowed for this purpose. There are six platforms situated at convenient points along the line of railway, where the carts tip their loads into wagons. These wagons are made up into trains and hauled away by locomotive engines to the Salt Water Lakes for final disposal of their contents. Notwithstanding a vigilant outlook, constant trouble has been experienced through cart drivers illicitly working on their own account by fetching canal earth into town.

The rule limiting depositing of house refuse on streets to the hours between midnight and 5 a. m. applied as a tentative measure to Chowringhee road and Park street, in consequence of complaints made by certain of the European public of refuse lying in the street to an inconvenient hour of the day, in the previous year having been found to work well, it was decided by the commissioners to extend its operation ; and at about the middle of the year under report all the thoroughfares in wards 15, 16, and 17 and the principal thoroughfares in wards 13 and 14 were brought under its operation with good effect. Thus in the southern division of the town, in most of its thoroughfares, refuse is now found ready for removal at a very early hour in the morning, and when it is once removed the streets are free from the nuisance for the remainder of the day and until midnight. In the northern division, the native part of the town, however, it is still to be lamented that refuse is thrown out at all hours of the day and night, and as a consequence it is the normal thing to find streets littered almost immediately after they have been cleaned, and to see refuse everywhere at any hour of the twenty-four. This is rapidly becoming too distasteful a state of things to the native population, if one may judge by the frequent complaints received, for it to be of much longer continuance.

The efforts of the department to clean the streets in an efficient manner, and to remove the sweepings and house refuse expeditiously, obtained the best results consistent with the means at its disposal. Operations were in many streets continued to a later hour of the day than sanitarians might think consistent with healthy surroundings, particularly in the business and crowded parts of the native portion of the town.

A small establishment of coolies has been provided for the prompt removal of horse droppings in the more important of the main thoroughfares, and so far this item of work was fairly performed, but a much larger establishment may be necessary in order to arrive at desirable improvement.



The daily average number of carts at work during the year, exclusive of the extra establishment mentioned, was below what should have been received, principally in consequence of insufficient provision to meet the percentage of cattle always sick, laid up in hospital, or unavailable for want of training, and particularly owing to the operation of the Gowk-hannahs ending in a result below the budget sanction.

*Cleansing and maintenance of sewers.*—The sewers have been regularly and systematically examined, and all deposits found therein and in their adjuncts has been removed by the establishment of dhangurs specially appointed for such work, the general system being to commence with larger and lower-lying sewers and work upwards series by series.

The deposit, which is road detritus, on removal by the dhangurs is immediately taken away in hired box-carts and utilized for filling up low ground and mixed with ordinary earth for forming a top-dressing to filled-up tanks.

*Flushing of sewers.*—The penstocks at the river inlets of the five main receiving sewers were raised whenever the tide-table promised a useful height of water, and even oftener. The lighter flushes were of little use except to assist the dhangurs somewhat in the loosening and removal of the deposit. Even the heavier flushes removed only the finer and lighter particles of the deposit, the coarser grit being moved but for a short distance, when it again deposited and had to be removed by manual labor.

The pipe sewers were regularly flushed in turn. The water used was obtained from adjacent tanks and wells constructed for the purpose by means of portable hand-pumps, and the unfiltered as well as the filtered water-supply was continued on until the hot months set in, when the use of filtered water was discontinued.

#### STORM WATER DRAINAGE WORKS IN CALCUTTA.

The design of these works, as is well known to the commissioners, is for the purpose of intercepting the storm waters of Calcutta from discharging into the Circular Canal and carrying them to a point in the direction of the natural outfall,  $5\frac{1}{2}$  miles east of the Hooghly River. The works are confined to four principal groups, viz:

(1) *The intercepting sewer.*—A cylindrical structure 9,585 feet long, and from 7 to  $10\frac{1}{2}$  feet internal diameter, extending from Halsee Bagan to Palmer's Bridge. This sewer in its course picks up the lower ends of the old storm outfall sewers in Halsee Bagan, Manicktollah, and Moonshee Bagan, and also of the new sewer 1,318 feet long and 4 feet diameter in Gas street. This work has four sluices in connection with the Circular Canal for flushing purposes.

(2) *The junction sewer at Palmer's Bridge.*—Beginning from its west or up-stream end, this work consists (a) of two segmental arched culverts, each of 20 feet span, with a dividing wall between them, connected with the general sump of the Calcutta sewerage and with the intercepting sewer; (b) of a junction chamber of the full width of the work arched over, and which forms a ventilator and gives access by two flights of steps to the interior; (c) of a three-fold culvert, each cylindrical barrel of which is 12 feet diameter, with the usual down-stream apron and revetments, and (d) of an inlet-sluice with two vents, each 9 feet high by 6 feet wide, making a connection with a branch of the Circular Canal for flushing purposes. A pair of large draw-shutters governs the connection between the sewer sump and this work.

(3) *The open cut.*—This work is a cutting 3 miles long with a bottom width of 20 feet, side slopes  $1\frac{1}{2}$  to 1, and has a mean depth of  $10\frac{1}{2}$  feet. It is crossed by two accommodation bridges, and four foot bridges, and is provided with masonry inlets for drainage of the locality it traverses. This work connects the junction sewer at Palmer's Bridge with—

(4) *Makalputta Sluice.*—This work is the outfall of the series. It has four openings, each 10 feet wide, provided with iron self-acting gates arranged in the manner of lock-gates pointing outwards to the tidal creek beyond.

With the exception of the bottoming out of about 3,000 feet in length of somewhat difficult work, where the open-cut appropriates a portion of the Rajah Khal, the whole series of works have been satisfactorily completed by the contractors, Messrs. Mitchell & Co.

*Survey of the suburban area.*—The area lying between the circular road and the canal having become considerably affected by the storm-water works, it became imperatively nec-

essary to devise for it a complete drainage scheme; and for this purpose a careful survey was started of the entire locality. The area amounts to 2,218 biggahs, of which about 1,888 biggahs were completely surveyed and checked by the close of the year, and the remainder is in progress.

*The use of the works.*—Owing to the exigencies of the season, the series of works were first put into operation in July, 1883, before the open-cut was completely bottomed out as before mentioned. Barring this drawback, everything has worked well, and answered the intended purpose. Mr. Thomas Fouracres was the assistant engineer in charge of the works up to the end of February, 1884, when he was transferred to the works for extension of the water supply.

#### DEATH RATE OF CALCUTTA.

On the factitiously favorable light in which the mortality statistics place the public health of Calcutta I need not dwell. It has been commented upon by former health officers, who have shown that much of it is due to the fact that the population of Calcutta is largely an immigrant one, and for the most part at an age when the chances of life are at their best. The census figures show that more than half the population are in the full vigor of manhood and womanhood; and that the majority, when they become seriously ill, leave Calcutta for their homes.

The difference in rate of mortality between the races is great. The mixed races have the highest death-rate, viz, 35.2, the Hindoos and Mohammedans come next on the list, with death-rates of 28 and 24 per 1,000 respectively, and lastly the non-Asiatics, with a death-rate of 12.7. Little can be deduced from these figures. It would appear that the mixed races, who as a class are more permanent as regards residence in Calcutta than other races, have the highest death-rate. Their mortality might be considered as a more accurate estimate of the actual death-rate of the town, but the population numbers on which the statistics are based are not altogether relied on, owing, as stated in the census report, to the likelihood of many including themselves amongst races to which they did not really belong.

It will be noted that the deaths from bowel complaints are subjected to the same fluctuations as cholera. When cholera is very high bowel complaints rise also; but ordinarily when cholera is high, bowel complaints are low, and when cholera is low, bowel complaints are high. For seven months in the year, January, February, March, May, June, August, and September, the registered deaths from bowel complaints were more numerous than those from cholera. It seems probable that cholera is frequently registered as bowel complaint.

*Comparative mortality in the town of Calcutta and its suburbs, from 1877 to 1886.*

Years.	Town.		Suburbs.	
	Actual number of deaths.	Ratio per 1,000 of population.	Actual number of deaths.	Ratio per 1,000 of population.
1877.....	13,704	31.6	14,025	55.7
1878.....	16,396	37.8	17,459	69.4
1879.....	13,044	30.1	13,835	55.0
1880.....	11,681	26.9	11,216	44.6
1881.....	13,030	30.3	11,143	44.3
1882.....	13,177	30.4	10,470	41.6
1883.....	12,325	28.4	10,429	41.4
1884.....	12,256	30.5	11,389	45.2
1885.....	12,707	29.3	11,267	44.8
Mean number.....	13,258	30.6	12,359	49.1
1886.....	11,447	26.4	10,187	40.5

In the above table the mortality of the town is contrasted with that of the suburbs. In both town and suburbs the death-rate in 1886 is the lowest for the past ten years. In the town it was 26.4; in the suburbs, 40.5.

The cholera mortality in Calcutta exceeded by 97 the mean of the last ten years. The number of registered deaths amounted to 1,741 against 1,644, the average number of the decade.



In the accompanying tabular statement, in which is given the monthly deaths from cholera in Calcutta since 1865, and to which is also added the rain-fall in each month. It will be noted that the cholera mortality of 1886 ranks as high as fifth on the list of these seventeen years which have elapsed since the introduction of the water supply.

*Statement showing monthly cholera deaths and rain-fall in inches in the town of Calcutta from 1865 to 1886.*

Years.	January.		February.		March.		April.		May.		June.		July.	
	Deaths.	Rain-fall.	Deaths.	Rain-fall.	Deaths.	Rain-fall.	Deaths.	Rain-fall.	Deaths.	Rain-fall.	Deaths.	Rain-fall.	Deaths.	Rain-fall.
1865.....	136	.48	396	1.86	508	1.96	756	4.28	400	15.95	131	8.63	162	12.19
1866.....	509	1.91	826	3.74	193	.....	736	1.84	616	2.56	885	7.02	552	13.42
1867.....	67	.55	142	.82	292	1.57	343	.27	315	2.46	137	6.12	108	15.44
1868.....	252	.05	328	.18	694	.16	591	5.47	360	5.8	174	26.61	97	11.17
1869.....	264	.9	428	2.72	759	4.59	745	.2	697	3.25	336	18.84	77	14.54
Mean.....	245	.78	424	1.86	689	1.65	634	2.41	477	6	332	13.44	199	13.35
1870.....	171	.77	259	.....	257	.03	381	4.03	165	.92	118	16.09	50	10.90
1871.....	53	.....	96	.75	55	5.41	85	5.72	29	11.08	23	25.35	25	15.93
1872.....	77	.22	78	2.82	61	.21	67	1.83	63	1.99	52	9.45	68	5.55
1873.....	129	.....	185	.....	217	1.18	159	1.84	149	3.78	95	4.3	55	14.76
1874.....	62	.94	175	3.77	186	1.94	243	1.2	210	1.16	79	6.81	35	8.89
1875.....	126	1.27	69	.....	264	.....	264	4.18	115	5.24	62	11.83	28	13.9
1876.....	90	.....	226	2.93	324	4.36	268	.2	168	2.93	126	9.32	42	19.39
1877.....	251	2.9	130	2.26	174	.75	184	.88	76	4.9	28	4.33	26	14.9
1878.....	65	.....	98	.54	312	.77	308	3.18	131	13.11	47	4.87	39	9.7
1879.....	73	.....	58	.21	145	.....	175	.....	318	3.23	223	7.01	56	11.52
1880.....	71	.05	114	2.91	90	.54	71	1.91	47	4.87	11	14.07	17	13.69
1881.....	63	.....	72	.....	227	3.45	370	1.97	138	7.4	36	15.12	49	13.42
1882.....	129	.13	111	3.42	170	.52	318	.25	380	6.05	254	9.99	54	11.76
1883.....	204	.07	129	2.09	227	1.52	490	2.96	393	1.18	130	10.2	38	16.16
1884.....	36	.02	123	.29	486	.06	847	1.88	283	5.86	129	11.72	54	11.96
1885.....	79	.42	153	2.02	242	1.01	356	.66	147	4.84	70	11.4	131	8.12
Mean.....	105	.42	130	1.5	215	1.36	287	2	176	4.91	93	10.74	48	12.53
1886.....	140	1.28	70	.....	146	2.35	120	.....	65	7.93	28	11.52	95	15.35

Years.	August.		September.		October.		November.		December.		Total.	
	Deaths.	Rain-fall.	Deaths.	Rain-fall.	Deaths.	Rain-fall.	Deaths.	Rain-fall.	Deaths.	Rain-fall.	Deaths.	Rain-fall.
1865.....	392	5.99	496	10.25	432	.....	817	.....	452	.....	5,078	61.58
1866.....	491	11.48	371	15.97	236	7.83	203	.....	208	.....	6,826	65.74
1867.....	56	18.5	150	13.7	277	8.45	243	4.85	140	.....	2,270	72.73
1868.....	395	24.83	188	15.69	350	1.53	405	.....	352	.....	4,186	91.49
1869.....	52	6.02	40	7.91	56	3.03	77	.....	57	.....	3,582	62
Mean.....	277	13.36	249	12.7	270	4.17	349	.97	241	.....	4,388	70.71
1870.....	40	12.92	29	9.01	36	3.93	21	1.66	31	.....	1,558	60.26
1871.....	41	12.11	69	9.93	85	7.03	127	.....	108	.....	796	93.31
1872.....	76	11.52	57	8.42	82	8.93	177	.02	244	.09	1,102	51.05
1873.....	27	10.23	22	5.82	20	2.4	23	.14	24	.82	1,105	45.27
1874.....	32	10.19	17	12.67	22	13.71	60	.12	124	.....	1,245	61.48
1875.....	31	12.64	50	7.41	145	3.42	353	.....	167	.....	1,674	59.89
1876.....	32	24.85	31	10.26	41	5.8	259	.19	244	.....	1,851	80.23
1877.....	77	16.47	119	8.98	162	2.4	85	.....	106	2.19	1,418	60.96
1878.....	57	11.75	45	10.92	34	2.07	84	1.13	118	.51	1,338	58.55
1879.....	21	12.43	19	7	17	1.71	21	.....	60	.41	1,186	43.52
1880.....	22	13.26	18	12.96	55	5.03	170	.02	119	.15	805	69.46
1881.....	59	19.61	80	6.75	100	1.5	232	.....	267	.36	1,693	69.58
1882.....	52	10.87	38	10.5	91	11.08	232	1.61	411	.....	2,240	66.18
1883.....	38	8.15	38	6.96	162	.75	103	.....	85	2.54	2,037	52.58
1884.....	29	10.97	44	16.63	49	3.71	114	.01	78	.....	2,272	62.61
1885.....	57	26.5	31	5.51	34	5.29	105	.06	198	.89	1,603	66.72
Mean.....	43	14.03	44	9.42	71	4.92	135	.31	149	.49	1,495	62.6
1886.....	55	8.93	80	13.93	283	3.91	369	.....	290	.....	1,741	65.2

The first six months of 1886 were not marked by any great prevalence of cholera, and the number of deaths which occurred in March and April were rather fewer than usual; but in October, November, and December an outburst severer than that recorded for the same months during the past eighteen years occurred.

The Hindoos and Mahomedans have most of the cholera divided between them. The Hindoos contribute 70 per cent. of the deaths, the Mahomedans 26 per cent., and the remaining races, Europeans, Jews, Eurasians, etc., about 4 per cent. The difference in population of the different races in Calcutta will hardly account for the liability of each; but the explanation is rather to be sought in the customs of the people, the manner of preparing their food, and the insanitary condition of their dwellings.

The incidence on European sailors visiting this port, and who, when on shore, frequent many of the worst parts of the native quarters of the town, breathing its foul air and partaking of drinks diluted not always with hydrant water, is seen by the following table to be very heavy.

*Cholera deaths amongst European seamen in port.*

Years.	Average European population in port.	Deaths from cholera.	Death rate per 1,000.
1879.....	1,000	25	25
1880.....	1,400	14	10
1881.....	1,350	33	24.4
1882.....	1,792	37	19.8
1884.....	1,684	36	21.3
1885.....	1,693	7	4.1
1886.....	2,326	26	11.1

The cholera mortality is seen to be thickest along the riparian districts of the town and also in the central portion of the town on the east side of Machooa Bazar street, a street continuous with the Hooghly Bridge. In fact, if this club-shaped portion of the town were excluded (*i. e.*, the northern riparian district being the handle, the southern riparian district and Machooa Bazar street being the head of the club), although it is a small part of the town, yet the majority of the cholera deaths would also be excluded.

The deaths are densest in the most crowded and most filthy localities of the town. In that part of the town where the cholera gains its greatest intensity, viz, near Machooa Bazar street and Cotton street, there the streets are narrow, the houses are crowded together, with but narrow and zigzag passages between them, by which access is obtained to each; the huts and houses are planted pell-mell, with no relation to order or convenience of access, both the huts and houses teeming with human beings. Filth inside the houses and huts, seething filth outside, gully-pits leading to drains choked, sewer-gas of the most offensive kind pervading the whole atmosphere, is the normal condition. Nothing short of a wide street, at least 90 feet wide, through this frightful locality, sweeping away the existing dens and then rebuilding with some attention to order and regularity, will be of any effect.

#### FILTHY BUSTEES AND CHOLERA.

In relation to the condition of the bustees, the following remarks are extracted from my quarterly report:

With few exceptions the huts and their surroundings are kept in a most filthy condition. The compartments, into which a hut is divided for separate families and individuals, are kept clean internally, but the central court or compound is almost invariably a receptacle for refuse; filth of every description is to be found there. There are certainly exceptions where the inmates keep their huts clean, but the good effect of individual effort is lost in the overwhelming result of their neighbors' filth. The air of these localities is entirely polluted. To obtain a proper removal of filth and a moderate degree of cleanliness, the compounds and surroundings of all huts must be subjected to a systematic and regular inspection.



The overcrowding of huts is another element that contributes to the unhealthiness of the bustees and favors the ravages of cholera. On a vacant piece of land a hut here and a hut there has been erected, with practically no restrictions, as long as it was 2 or 3 feet from its neighbors and in a line with one of them. Gradually the whole of the vacant land has in this manner become closely packed with huts, having only a few narrow, crooked, and winding passages as means of ingress and egress for the inhabitants. It is impossible for fresh air, which would purify and bring health to these places, to gain access, and it is equally impossible for the scavengers' cart to gain admittance. Two of the most important factors in the health of a locality, efficient ventilation and scavenging, are wanting, and two of the most potent factors favorable to cholera are present, viz, stagnant air and filth. The improvement of the old bustees is a work of the highest importance, but hand in hand with it the starting up of new bustees or huts require to be brought under proper control; otherwise the commissioners will find that the work of improvement will be abortive. If this evil is to be avoided, *a minimum width for the roads in front and back of single line of huts* should be stated in the proposed amended municipal act. Good building regulations are urgently required, nor should the regulations be framed for huts only, but also for brick-built houses, many of which, especially in the northern part of the town, are taking the place of huts, and will eventually lead to greater difficulties in the way of improvement than those now caused by huts.

The ill effects of the overcrowding of the people in the huts would be necessarily lessened by having in the building regulations of the municipal act a stated *minimum height for the compartments of huts*. To enter many at present one has to stoop, the height being sometimes not more than 5 feet, sometimes less. A minimum regulation height with good roads for ventilation and scavenging would probably be all that could be done in the meanwhile. Later on the commissioners may see their way to having regulations framed restricting the number of occupants residing in the extremely overcrowded huts in the northern portion of the town.

This is a good example of the manner in which cholera will confine itself during an outbreak to a special locality, and leave untouched surroundings in a similarly unsanitary condition. So far as inquiry elicited, the explanation here seemed to be that the tanks I, VII, and XI were successively contaminated with cholera poison, and those who used the water were attacked. Then tank VI, after a time, became similarly contaminated, and an outbreak amongst the inhabitants surrounding its banks took place. There were peculiar facilities for the four tanks in question becoming contaminated on one of them being polluted, as the inhabitants of this quarter were mostly of the same caste, and there was a good deal of visiting and remaining with friends who had taken ill, and partaking of the same food and bathing in the same tank. I will not say that the water was to blame for all the cases. In a few instances the explosions were very intense in badly ventilated huts in which a cholera case had previously occurred.

Similar cases could be mentioned in which the localized influence of the tanks, public and private, is remarkably evident. In the southern part of the town, in Bamun Bustee, there was a localized outbreak around the only tank in the bustee, and apparently traceable to a cholera case brought to a hut on the edge of the tank; other instances occurred in houses with private tanks.

The tanks themselves do not appear to be dangerous if they could be properly conserved, but the customs and habits of the people are such that the water may have added to it at any time, either directly or indirectly, a poison which acts with no less certainty than sparks to gunpowder.

There were many other cases, however, throughout the town, and perhaps the majority in localities where there were few tanks or none at all. For example, the bustee called No. 2, Bonomally Sircar's street, is situated in the northeast of the town, in Coomartolly and close to the river. There is only one tank, but every hut has its well. The previous history of cholera in this bustee is instructive. The prevalence of the disease is shown as follows:

From 1876 to 1880 there were 46 cholera deaths, or an average of 9 per annum.

From 1881 to 1885 there were 114 cholera deaths, or an average of 22 per annum.

In 1886 there were 15 deaths.

The second period of five years was thus distinguished by an increase of 148 per cent., or nearly two and a half times the mortality of the first period.

This bustee has not a very large population, and there have been no great changes in either the class or population or numbers during the 11 years under consideration. It is apparent, however, that the inhabitants are more subjected and prone to cholera within the last six years than formerly. In 1878 the bustee was to a certain extent improved, the owner having constructed a main road and several side roads through the more crowded parts. At the same time underground drains were laid down and connected with gully-pits situated at the side of the narrow road, also with other gully-pits which are sometimes inside the confined compounds of the huts themselves. In addition to these changes, a water-supply pipe was carried into the bustee in October, 1884, and a stand-post erected in the main road near the center of the bustee. Notwithstanding these improvements, cholera prevailed severely. The deaths in the different years have been as follows:

Years.	Deaths.	Years.	Deaths.
First period :		Second period :	
1876.....	8	1881.....	27
1877.....	14	1882.....	27
1878.....	8	1883.....	17
1879.....	5	1884.....	34
1880.....	11	1885.....	9
Total.....	46	Total.....	114
		1886.....	15

For a year after the introduction of the drainage and other improvements, there was a slight decrease in the cholera mortality, but in the following years that improvement changed into a deterioration worse than had existed before any alterations were made until in 1884, when seasonal conditions were favorable to cholera; 34 deaths occurred in this small bustee, 27 of these in the first half of the year. In one quarter the cholera death-rate reached nearly 80 per 1,000 per annum of the population. After this outburst a water-pipe was laid down. In 1885 there were only 9 deaths, but in 1886 the mortality rose to 15, the greatest number occurring in the fourth quarter of the year. This latter outburst led me to inspect the locality. On entering the bustee, the first thing that struck me was the foulness of the air; a most offensive sewer odor was experienced; the atmosphere was thoroughly impregnated with gases proceeding from the drains and gully-pits. I had the underground drains opened and exposed to view for thorough examination. They were found to be choked with filth, emitting fetid, noisome, nauseating effluvia. Portions of the drains were completely blocked up, the contents escaping into the soil, polluting the subsoil and under-ground water, on which the numerous wells in the village depend for their supply of water for domestic purposes.

In addition to this, the water which had been led into the bustee in 1884 could not be said to have been of any great advantage, for, in consequence of want of pressure and scarcity in the locality, the supply was extremely scanty. With reference to the scanty supply of water, the following extract from my report for the fourth quarter of 1886 describes the water famine, not only in the bustee but also in other localities.

#### SCANT WATER SUPPLY AND CHOLERA IN CALCUTTA.

I would particularly direct attention to this scarcity of water in the parts affected. Go almost where one may in the north part of the town, and especially in the riparian wards, there is the same complaint of want of water, and a very valid one it is. It is a common occurrence to see the people grouped around one of the stand-posts waiting for their turn to fill their chatties, many of them to be disappointed; for the water from the stand-posts often comes in mere dribblets, and the supply is exhausted or turned off before half the people are



supplied. In Goormartolly district, where cholera has been very severe, I have myself seen a small chattie which contains about two gallons take one-quarter hour to fill. That the supply of water in these localities or in particular parts of those localities is a diminishing quantity, is evidenced by the fact that the taps used to be 4 and 5 feet above the ground; gradually they have had to be lowered until many people have had to sink wells in their premises, and receive the water from the tap at the same level as the pipe is laid in the ground. Scarcity of water brings in its train a great deal of sickness apart from cholera. The districts which have suffered most from scarcity of water have suffered also from a large amount of sickness, more particularly of a dysenteric character. The cholera appears to have been preceded by a period of dysenteric prevalence.

This water famine, as I shall afterwards show, has apparently supervened gradually within the last few years. Previously, although hydrant water had not been carried into the bustee, there was no water to be had in the streets adjoining.

The bustee before 1879 was in a crowded and filthy state, with wells in nearly every hut, but with plenty of pure water on the outskirts of the bustee, and which the inhabitants resorted to. A certain amount of cholera prevailed in the bustee, attributable to its insanitary condition and the use of polluted well water. Some narrow roads were afterward constructed, which helped in a measure to ventilate the bustee and purify the air; then the underground drainage was extended. This after completion is neither flushed nor cleaned, but left to take care of itself; consequently in a short time the drainage becomes a seething cess-pool of decomposing filth, which, escaping from the pipes, finds its way into the soil and the underground water, and creates a stinking atmosphere. About the same time the pressure of hydrant water becomes less, and gradually the plentiful supply formerly obtained from the neighboring streets is unobtainable. Even though a pipe is placed in the bustee the inhabitants are compelled to fetch most of their water from the river and to use more and more the water from their polluted wells.

Under these circumstances it is not surprising that cholera should have become worse. Even though the bustee is less crowded than formerly, its foul drainage and impure water supply place it in a much more insanitary condition than before. In thus bringing into prominence the condition of the drainage and attributing to it ill effects I am not condemning the system of town drainage. An effective underground drainage is one of the most potent agencies in promoting the health of a town, but the drainage in the condition described as existing in the bustee, and likewise in many others, is infinitely worse than no drainage at all.

Certain principles must always be kept in view in introducing drainage, whether in a hot or a temperate climate: First, proper and judicious construction, under reliable and skilled supervision; second, efficient ventilation; third, constant flushing; and, fourth, periodical inspection. None of these obtained in relation to the underground drainage of the bustee in question.

#### FAULTY REGISTRATION OF DEATHS IN CALCUTTA.

Death registration, as carried on in Calcutta, whether considered in regard to numbers, locality, or cause of death, is altogether unsatisfactory. As regards numbers, section 174 provides that a death shall be registered at the office of the registrar of the district, or at the burning ghat or burial ground. To this end 18 district registrars, one for each ward of the city, and 7 subregistrars were appointed. The subregistrars were placed at four of the more important burning and burial grounds. By section 172 of the act the registrar is required to inform himself of every death happening within his district, and to ascertain and register the particulars of every such death. Evidently, therefore, it was the intention of the legislature to make the ward registration the basis for compiling the vital statistics. On the other hand, the subregistrars' functions were to be subsidiary to those of the registrars, and were to be used as a help and check in the ward registration. In the working of the present system, however, the chief burden falls on the subregistrars, while the registrars' returns are rather made use of by the way of supplementing the returns of the subregistrars. When, for

instance, a death takes place, the custom is to at once remove the body to the burning ghat or burial ground. The subregistrar, if there is one, registers the name and address of the deceased and the cause of death from the information given to him by the friends who bring the body. The burning or burial is then proceeded with. Subregistrars are regularly stationed at all the burning ghats; but at some of the burial grounds the case is different. Should there be no subregistrar, the burial takes place, and the relatives or friends of the deceased are expected to have the deaths registered at the registrar's office in the district in which the death took place. As, however, the district registrar has no means of discriminating between deaths which ought to be registered at his office and those which have been registered at the burning ghat or burial ground, any neglect to register in cases where bodies are buried in a ground unprovided with a subregistrar, is not easily discovered. As a matter of fact, a good deal of confusion arises. We find about half the deaths registered both by the registrars and by the subregistrars. Every month, however, a few deaths occur in the registrars' books which are not to be found in the subregistrars' books. These may be taken in most instances to represent burials in grounds other than those in which is a subregistrar, but we have no means whatever of knowing what other persons have died in the ward and been disposed of in like manner.

Again, as to locality, registration not being compulsory in the district in which the death occurred, very unreliable particulars are entered in the subregistrar's book. Touching one disease—cholera—recently I have had an inquiry instituted into every death. In three months, of 675 cases registered as cholera 141, or 20 per cent., had wrong addresses entered in the subregistrars' book; 13 per cent. of them were traced, while 7 per cent. could not be traced. If inquiry were made into the other registered deaths, probably a similar result would be obtained.

There will always be great difficulty in obtaining anything like an accurate registration of the causes of death, due mainly to the fact that a large percentage of the population when ill never call for qualified medical aid. For that portion of the population we must in the mean time be content with the present primitive system of ascertaining the cause of death. The registrar or subregistrar asks the friends of the deceased regarding the nature of the disease, and the answer given by the friend or relative is duly registered as the cause of death.

#### FILTHY DWELLINGS AND INADEQUATE SANITARY INSPECTION IN CALCUTTA.

Regular inspection of premises is the only method by which the extremely insanitary condition of most of the dwellings in the native quarter of the town can be removed, and such functions of inspection imperatively call for an establishment of the same order as that which obtains in other civilized communities. The streets may be well cleansed but if the conditions in and around the dwellings are not dealt with, the primary evils injurious to health remain untouched. Choked drains, filthy compounds, every conceivable condition of unhealthiness which a day's inspection of any of the native quarters of Calcutta brings to light—all this is unaffected by the mere cleansing of the streets and bustees. The process is a whitewashing of the outside, while the inside, though in a worse and more dangerous condition, is left untouched.

The two accompanying photographs will afford some conception of the condition of the majority of the compounds in the huts and houses, while it furnishes demonstration of the need which exists of regular sanitary inspection throughout the native town. The hut is of the ordinary bamboo make, the walls plastered with mud and cow-dung. It is almost square in shape, occupying 1,254 square feet, and inclosing a very small compound of 85 square feet. Around the compound are eleven apartments, each occupied by a separate family; within the premises is the privy, the drainage from which flows into a drain close to the well. When visited the hut had 26 occupants. There had been 3 deaths a few days before.

The photograph shows the relative position of well, privy, and drain; also of a gully-pit leading to the bustee drain which is connected with the street sewer. The drains, in a broken or dilapidated condition, or are seen to almost surround the well. This well forms part of the side of the passage leading to the privy, the drainage from which, on its way to the gully-pit,



discharges a portion into the well. The gully-pit is broken, and sewer gas escapes into the compound. The feelings which one experiences on entering compounds such as these is that of being stifled for want of fresh air. The gentleman who took the photograph for me was sickened over the operation, and several times I had to quit the compound and hasten into the street, so oppressive was the foul air which had to be breathed.

Such and worse conditions can be found in thousands of places in this city, and it is for these that sanitary inspectors are required.

Reproduction from photographs showing condition of compound of a hut inhabited by 26 persons, and in which 3 died of cholera.

Illustrations Nos. 13 and 14 show the same compound from two different points of view.

#### DESCRIPTION OF DETAILS IN NOS. 13 AND 14.

1. Entrance to privy.
2. Drain, covered with tiles, leading to privy.
3. Continuation of drain No. 2.
4. A second drain, covered with tiles, leading to gully-pit.
5. Surface grating, taking off water from compound into gully-pit.
6. Gully-pit close to well and into which the several drains discharge, and which is connected with the bustee underground drainage.
7. Well, surrounded by broken drains.

#### ABOLITION OF SANITARY INSPECTORS—FALSE ECONOMY IN CALCUTTA.

Another sanitary duty requiring competent medical or sanitary inspectors is the inquiry into the causes of disease. No case of cholera, typhoid fever, or small-pox occurs in a house without an antecedent cause. For intelligent action in checking further progress of the disease the case needs to be inquired into and measures taken accordingly. For example, in small-pox, besides the ordinary measures of disinfection, isolation, and vaccination, it is important to ascertain where the patient caught the disease in order that the source may be traced out and dealt with; then, in cholera and typhoid fever, in addition to removal of conditions found on the premises which are likely to be a nursing-ground for growth and extension of these diseases, inquiry ought to be made as to how it came to pass that cholera broke out there, and if traceable to other causes.

It is only in this way by acting on positive information, and not at random, that check and control can be kept over zymotic diseases. None of these sanitary duties can be performed without an agency. The commissioners in November last, at a time of panic caused by the great prevalence of cholera, were under the circumstances influenced by my advice, and sanctioned as the nucleus of a sanitary staff or department, 4 medical men as inspectors and 9 sub-inspectors for removal of nuisances, disinfection of premises, and inquiry into disease. These accomplished very good work and something like an organized attempt was being made to remedy a few of the extremely insanitary conditions in the town; but now, after 6 months' work, the whole organization has been broken up and dismissed on the ground of economy.

	Per month.
	Rs.
Four medical inspectors, at Rs. 100 per month .....	400
Nine sub-inspectors, at Rs. 50 per month .....	450
Total .....	850

An inspecting establishment which costs less than £1,000 a year is considered too great an expense for a city with a half a million of inhabitants, the terrible insanitary condition of which I have frequently brought before the commissioners, and this while every exacerbation of cholera involves quarantine at European ports for vessels leaving Calcutta. Surely this is economy ill-directed.

*TANKS, WATER SUPPLY, ETC., OF CALCUTTA.*

So frequent reference has been recently made to the prevalence of water tanks among the dwellings of various portions of India, that it has been deemed advisable to introduce here a reduced official map of those two places which constitute a part of the southern suburbs of the city of Calcutta. The black parts of the map indicate the location and give the relative area occupied by the water tanks. (Consult map of Kidderpore and Alipore at head of this section.)

Within the city of Calcutta itself the tanks are almost equally numerous and extensive. The number and size of these tanks in Kidderpore and Alipore very fairly represent the number and relative area occupied by the water tanks in the native portion of Calcutta and of every village in Lower Bengal, and in many other parts of India where epidemic cholera is most extensive. The origin of many of these tanks is extremely ancient. Many of them are regarded as sacred, and from time immemorial as possessed of miraculous healing virtues. The most sacred and most frequently visited by the people going to them from a distance are those usually connected with temples; but the majority of the tanks owe their origin to the necessity of producing raised ground for the foundation of the dwellings of the native inhabitants. It will be seen by reference to the description of the physical conditions of Lower Bengal that the land between the tributaries of the united waters of the Ganges and Brahmaputra is usually below the level of the water flowing in these distributaries and is subject to frequent inundations. Besides this cause of superabundance of water at certain periods of the year, the rain-fall during the prevalence of the monsoon adds very greatly to the amount of water upon the land throughout the whole of this region. The earth required for the raising of the ground upon which the native huts are constructed is obtained by digging broad and deep holes in the ground. These holes vary according to the number of huts surrounding them, from an area of some hundred of square yards to that of several acres, and they have an average depth of from 10 to 15 feet. In addition to the excavation thus formed the number is constantly increased by a very prevalent custom among the inhabitants of the suburbs of large cities of engaging in the manufacture of bricks and tiles required for building purposes and of furnishing mud for the construction of the walls of native huts which are almost universally formed of this material, mixed with straw. During the heavy rains which occur constantly from the months of June and July to September and October these holes commonly called *tanks* are filled, and during the rest of the year when there is only a very light rain-fall, the water in them evaporates until towards the end of the dry season, that is in the spring months, the water becomes very slimy and very filthy. This tank water is commonly used by the inhabitants of the surrounding huts (the collection of habitations around one of these tanks being commonly called a "bustee"), as will be seen by reference to the abstracts of the descriptions already alluded to of the habits of the people.

By an examination of the accompanying plan of a small section of one of the wards in the native town of Calcutta it will be seen that in this collection of huts somewhat removed from the location of the tanks that there is also another occasional source of supply of drinking water, and another means of disposal of human excrement. This plan is a reduced tracing of a record in the archives of the town of Calcutta of a recent survey of this portion of the city, kindly furnished me by the chief health officer of Calcutta, Dr. Simpson. The circles in this plan indicate the location of wells; the square or oblong sections marked "P" show the location of private privies. It is thus seen that the water in the wells is within dangerous proximity to numbers of privies, and when the porous character of the alluvial soil is considered it seems impossible that this water can escape contamination. (Consult chart of Gougoulee Bustee at head of this section.)

The European population of many of the large towns and cities in India is supplied by public water-works, and in the course of time many of the natives, of the better classes in particular, notwithstanding the almost unconquerable tendency to adhere to old customs in everything, come to use the drinking water supplied by the public water-works. The city of Calcutta has had for a number of years a public water supply which is regarded in India and



boasted of by the authorities and sanitarians as one of the best in India. The water is taken from the Hoogley River, one of the distributaries of the Ganges, upon which the town of Calcutta is located, some 15 or 20 miles above the heart of the city. The water of the Ganges is extremely muddy at this point and everywhere else in its course from the upper valley to the Bay of Bengal. It is pumped up into large settling reservoirs, where the water is allowed to rest and deposit a considerable amount of sediment for 24 or 48 hours. It is then turned upon filtering beds, the filters consisting of several layers, the upper being extremely fine sand, the next layer consisting of sand of a coarser grain; beneath that is a layer of fine gravel, and lower still a layer of larger stones, and still lower a final layer of larger rocks. After passing through this process of settling and of filtering the very muddy water of the Hoogley has been deprived of nearly all of its suspended solid particles, so that the water finally conducted to the town of Calcutta by two large iron mains is perfectly clear and limpid. Not only has the coarser silt suspended in the Hoogley water been removed, but also, according to the bacteriological examination made by the German commission at the time of their visit to Calcutta, even such minute objects as bacteria have also to a very large extent been removed. One of these large iron mains conducts the water directly to a large covered reservoir near the center of the city, whence it is distributed during the day to the middle and lower portion of the city. The other large iron main is tapped at its entrance in the upper portion of the city for the direct supply of the northern wards. Thus it would seem that there is just ground for the pride of the people of Calcutta in the excellence of their public water supply. But however pure the public water may be when it reaches the distributing reservoir within the town, there are numerous opportunities for its contamination during the course of distribution. The objectionable practice exists in Calcutta, as in Bombay and in many other cities in India where they have a fairly good source of drinking water, of interrupting the flow of the water through the distributing mains. During the night the water is turned off from the city at the central reservoir, in order that the latter may be refilled during the night.

In many of the houses which are connected with the distributing mains in the city the water supplied to the water-closets runs in a constant stream during the day, and there is either a very inadequate means of closing the pipe at the water-closet or none at all. Furthermore, the system of underground drainage throughout the town is in many localities very faulty, the drains being frequently leaky, or even broken, and the same may be said of the house drains connecting with the sewers. These drains frequently are in juxtaposition with, or very close to, the water-mains, or the water-pipes connecting the mains with the houses. It can therefore be readily seen that when the current of water in the distributing pipes is interrupted during the night there is opportunity for the influx of a certain amount of sewage material directly by percolation through the soil, or the leakage from the street sewers, or the house sewers, and indirectly by a reflux into the water-pipes connected with the water-closets. Thus it is very possible that when the water is again turned on the distributing mains in the morning it may carry with it in certain limited areas a certain quantity of fecal and other sewage material. I refer to this fact especially because, although immediately after the introduction of this public water into Calcutta, the prevalence of cholera throughout the portions of the town supplied with this water was very markedly lessened, in later years after the system of underground drainage became more extensive the prevalence of cholera slightly increased again, and because this increase has been used by some writers as an argument against the theory of the transmission of cholera by drinking water. It appears to me that this later increase of cholera is to be attributed to the possibility of unsanitary contamination of the public water in the course of distribution, rather than to form the basis of an argument against the transmission of cholera by drinking water.

*Water-supply contamination.*—In some of the municipalities—Madras, Madura, Negapatam, and Salem—the people themselves are aware, or becoming aware, of the importance of the question, and where they have not already done so are beginning to remedy existing evils. Moreover, in municipalities the law protects or should protect the inhabitants. The Madras Act No. III of 1871, commonly called the Towns Improvement Act, places all public streams, channels, water-courses, tanks, reservoirs, springs, and wells under the direction and control of the commissioners, and gives the said commissioners power to fine and punish persons

fouling them. But in the hundreds and thousands of small towns and villages not governed by municipalities the people themselves have not the faintest idea they are doing anything wrong or dangerous in their daily mode of treating their water supply, and there seems no authority to prevent it. The people believe, on the contrary, that water itself purifies everything. Whilst writing this report the following reaches me from the sanitary officer of Madura as to the water supply of the town of Palni, a place much visited by cholera epidemics.

## WATER SUPPLY OF PALNI TOWN.

[Special report on the water supply of Palni Town by Surg. Maj. W. J. Hastings, M. D., district medical and sanitary officer.]

“Palni Town is situated on the margin of an extensive tank. The town is on a much higher level than the tank. Most of the surface drainage of the town falls into the tank.

“2. The greater part of the town is situated on the northwest margin of the tank. Many of the houses are so close to the water’s edge that a child might throw a pebble from the back yard of a house into the tank. House and yard and latrine filth, filthy rags, bones, offal, etc., lie on the sloping ground between the houses and the tank. Nothing intervenes between the filth and the tank to prevent the flow of water and filth into the tank.

“3. When rain falls, the tank becomes the receptacle for all the filth on the surface of the ground. The tank may be without exaggeration described as the cess-pit of the town. It is also the chief source of drinking water.”

The best, if not the only, remedy for this state of things would be the passing of a short act in the legislative council to protect in all these small towns and villages, as in the municipalities, the drinking-tank from pollution.

## WATER SUPPLY IN MADRAS.

*Water conservancy.*—In my last annual report I mentioned that the impression left on my mind from touring was that the great needs in sanitation were : (1) improved water conservancy ; (2) removal of filth from the interior and surroundings of houses. I must say my recent travels have but confirmed my first impression, only that I should feel inclined to put the first, viz., necessity of water conservancy, a long way before any other.

*Habit of the people compares favorably with Europeans.*—The people of India—and I am speaking of the multitude, the million—compare, I think, favorably as regards the interior of their houses with the multitude in European countries. I am or was, as a doctor, well acquainted with the interior of the houses of the poorer classes of England, Wales, and some towns of France, and I must candidly say I have found less repulsive filth in the interior of the houses of the people of this country, especially in the mofussil, than amongst people of the same class in Europe. But the treatment that drinking water undergoes in this country is not only appalling but perfectly inexplicable considering that it is so diametrically opposed to the commands laid down in their holy Vedas.

*The Shastrums on water conservancy.*—In the third or Yagur Veda the part called Arana contains the following commandments : “Do not spit out with retching in the water. Do not pass urine or discharge excreta in the water. Do not drop blood into water. Do not throw any hair, or nails, or bones, or ashes, nor dip dirty clothes into water. For to do so is to abuse a precious gift of the gods and disgrace them.”

Menu, the Lawgiver, says : “Let him not cast into the water either urine or ordure, nor saliva, nor cloth, nor any other thing soiled with impurity, nor blood, nor any other kind of poison.”

*The commands of the Shastras set at naught.*—Nothing, therefore, can be plainer than the commands of their own lawgivers on this point, and yet from Cape Comorin to Cuttack, and from Madras to Mangalore the whole length and breadth of our presidency, and—from letters I have received from Bengal since I lectured on this matter at Patcheappah’s Hall—most prob-



ably I might fairly say the whole length and breadth of India, every tank and water source is more or less defiled by "spitting with retching, passing urine and other excreta, and washing filthy rags in the water."

*Personal experience of the defilement of water.*—In my report for 1880 (paragraph 125, page 78) I wrote: "I carefully watched at some tanks, for instance at Hosur, Bellary, Mayaveram, etc., people washing their clothes and persons in tanks, from which the women were taking home vessels laden with water for cooking and drinking. This water in one or two places when examined was found to give every possible evidence of impurity, etc." I have continued this examination at every place I have visited and found the practice the same. It is not that the water contains a thousandth part more or less of a milligram per liter of ammonia or any other objectionable salt, such as analytical chemists determine with so much nicety in Europe, it is that the water is to the naked eye and nose in almost every instance a palpably unclean, offensive, dirty fluid, in which almost any amount of a solution of the permanganate of potash dropped in loses its color. It would rank in Europe as simple sewage.

*Ananta Iyer's well at Coimbatore.*—And lest I should be deemed guilty of exaggeration let me add a few notes of what I have seen in recent tours. In Coimbatore, situated in the middle of the town, is a splendid well, called Ananta Iyer's well. It must have cost a great deal of money to construct, and is really a magnificent well, giving an abundance of clean, sparkling, cool water, even in the hottest weather, but owing to neglect is defiled every day. The yard in which is the well is paved with large flag-stones, but these in course of time have in many places become displaced, and the consequence is that the water in which the people around, after the custom in India, and a very bad custom it is, have washed their bodies and clothes, trickles back into the well through the sodden earth instead of running clear away, as was intended when the well was originally constructed. Looking at the well whilst the process of washing, etc., was going on all around, we could see the water streaming back down the side of the well, the wall of which was discolored from the percolation.

When the cholera was making its way down from the northwest to our presidency, at the end of the last and commencement of this year, I was asked by Mr. Price, collector of Chingleput, to send him a few simple rules on sanitation of villages, that he might publish them in his district gazette. Subsequently hearing from him that the rules I had sent answered the purpose and were sufficiently simple and intelligible to the people, I took it upon myself to send a copy of them to all presidents of municipalities and local fund boards. Lately I found myself inspecting a municipality in the north (Berhampore), a long way from Madras, and the manager showed me, amongst the proceedings of the commissioners of that municipality, a resolution calling attention to my circular, and resolving that two important tanks, which I will call A and B, should be strictly set aside for drinking purposes, and a policeman set over each to prevent people washing their bodies and clothes therein. Next morning we were going round the town, when the manager pointed out in the distance a bank, which he said was the bund of tank A—one of the tanks in which washing of bodies and clothes were strictly prohibited. We went, the doctor of the station as well as the manager of the municipality were with me. We were soon there, and certainly it was a magnificent tank. There were crowds of people at all four sides, and all, or nearly all, busily engaged in washing their clothes, and those that were not doing that were bathing their bodies. Just where we had reached the tank was an old man washing a not very clean cloth, and when he had done he washed himself, and spat repeatedly in the water. He then went away, and within a minute a woman came there, stood almost in the identical spot the old man stood a minute before, and filled two bright brass chatties with the water, and took them home for drinking and cooking. She must of necessity have taken home some of the filth from the old man's clothes and a portion of his spittle to drink and cook with. Now, what we have just seen under our eyes was taking place at various times of the day all around this tank, and not only all around this tank but around the hundreds and thousands of tanks which lie scattered over this fair continent of India.

In Vizianagrum I saw a tank, much frequented by the women, who in hundreds might be seen taking home chatties upon chatties of water for domestic purposes into which no less than eight large drains emptied themselves and the cattle in numbers were daily washed.

It is needless to go on repeating these examples; they are universal, and I may, perhaps, not be deemed quixotic when I say that with the example of Guntur before us, and the happy effects of careful water conservancy of late years at all the great fairs and festivals, I see no reason or difficulty why in every municipality and town, and presently in every village, the water for drinking purposes should not be carefully preserved from the frightful contamination which obtains at present.

I believe it would serve a useful purpose and induce the people themselves to assist in keeping their drinking water uncontaminated if at every tank thus set apart an extract from their own Vedas, such as I have quoted above, were legibly printed in the vernacular on a board and exposed in a conspicuous place.

Until this is effected, and, as I have pointed out in a recent letter to Government, it seems practicable at a comparatively small cost to municipalities and communities, all other sanitary improvements must be carried on in vain. Fairly clean, wholesome drinking water is a primary necessity for the sanitary welfare of a community. (From annual report of sanitary commission for Madras, 1882.)

*Water supply.*—In addition to the numerous private wells mentioned when speaking of houses there are 72 municipal wells which are sunk in rocky or gravelly soil to an average depth of 20 to 30 feet; these all contain good water and are kept in repair by the municipality. They contain a sufficient supply of water, if properly utilized, for the requirements of the town, *but unhappily the river is the main source of all the drinking water, and in spite of all warning and in spite of the evident defilement of the water by the filth from drains, the filth from dirty clothes, and the filth from men's bodies, the poorer natives (and it might have been added 'richer,' too) continue to drink the river water.* Now, the dhobies wash above the town at Fisher's anicut, the Brahmin women bathe, and, in connection with some religious ceremony, always wash their menstrual clothes there; below the anicut the Brahmins wash themselves and their household utensils for a distance of half a mile, then the other caste bathe, and below this is a temple where religious bathing is always performed. After the women have washed themselves and their clothes and their household utensils *they fill their chatties and lotas with water and take it home for household and drinking purposes.* Now, during the cholera epidemic of 1875, the part of the town first attacked was the fort near the pool above Aroonachellam's anicut, and here also the drains are most defective; the disease first spread down the river through Shevapett and Gogai, and during the present year most of the cases have occurred in the fort and at a chattram on the other side of the river, the occupiers of which use the water just above the anicut. These facts go far to prove the communicability of the disease by water. Here we have the water in which foul clothes have been washed flowing down until stopped by an anicut, and at this place, just when we might suppose the germs of the disease, if in water at all, would collect, we have the disease breaking out. This is the more remarkable, as when the disease ceased elsewhere it continued to hover around the spot. (From the Zillah surgeon's report, Salem (Madras), 1877.)

J. Butler Hamilton, M. D., brigade surgeon, Lucknow, in discussing the predisposing causes of typhoid fever in India (Enteric fever in India, Allahabad, 1888,) places the most active in the following order, the greatest first: I, recent arrival; II, youth; III, overstimulating diet; and IV, heat.

In speaking of the hygienic surroundings and popular customs of the people, he uses the following language: "From experience I can say that the environs of every village are practically an open cess-pit, and even in the immediate neighborhood of our military cantonments, matters are little better. The native of India is, perhaps, the most extraordinary anomaly in nature. Bound down by cast prejudices in a manner inexplicable to Europeans, he will throw away his food if even the shadow of a stranger or lower-cast native falls on his cooking place. Even in the matter of drinking, he is so particular that a Brahmin would die of thirst sooner than drink out of a vessel of a man inferior to him; yet this same Brahmin may be seen washing and drinking in a tank, the banks of which are covered with human excrement, washed by every shower into the water he does not hesitate to use for all domestic purposes."



## CHOLERA AND WATER SUPPLY.

In speaking of the course of a cholera epidemic in the Salem district, 1881, the official report runs as follows:

It appears, however, "that by far the greater number of deaths occurred amongst people using the river water," which is described as defiled "by the filth from drains, the filth from dirty clothes, and the filth from men's bodies." It appears also "that more than five-sevenths of the whole number attacked occurred amongst caste Hindoos—people who obstinately cling to the use of this river water from religious belief. The Mussulman population almost escaped; the European and East Indian entirely; and, strangest of all, the inhabitants of Kitchipolliem, chucklers, low-caste people engaged in most filthy occupations, also enjoyed an immunity from this dread scourge. They are not allowed to use the river water." The course of the disease is shown to have been mainly along the banks of the river, and the village of Kitchipolliem, mentioned as having enjoyed an immunity from the disease, is situated well away from the river. That the use of the river water alone is not to be justly saddled with the cause of the disease is evidenced by the statement that the division of the town in which the inhabitants used well water instead of that of the river suffered as severely from cholera as most of the other parts of the town along the river banks. Apart from all this it is added: "The curious feature of the epidemic is its weighty incidence on children; nearly one-half of those attacked were children under 15 years of age, and fully one-half of the deaths occurred amongst them." (Annual report of sanitary commissioner, Madras, 1881.)

*Water supply of municipalities.*—While the conservancy arrangements in regard to the removal of filth and rubbish, etc., from the roads and streets are fairly satisfactory, the same can not be said concerning the water supply, as in all Indian towns the principal sources from which water for drinking and domestic purposes is obtained are wells and tanks. In some towns water from rivers, channels, and springs is also used. On the whole the quantity is abundant, but in some towns during the hot weather scarcity is felt, and the people experience great difficulty in obtaining good drinking water. The original quality is generally good, but from the habits and customs of the native population the water supply is subject to all kinds of pollution. It is not an uncommon thing in a morning's ride round any town to see the water supply of some beautiful tank being contaminated and defiled in every manner of way possible by people of both sexes and all castes, in all stages of physical impurity and uncleanness, washing their dirty clothes and unclean bodies in the water, rinsing their mouths, and spitting into it. Even the supply from wells does not escape such pollution. Dirty chatties and buckets are dipped into them, and the people wash their clothes and bathe around them on the platforms, which from faulty construction or bad repair permit of the dirty waters percolating into the wells.

The banks of tanks and the approaches to them are generally used as latrines, and it is not unusual to find of a morning numbers of semi-nude people, without the least respect for modesty or decency, squatted all over answering to the early morning's call of nature; and it only requires one shower of rain to wash the deposits thus left into the tanks. The reason why they select these spots for the purposes of nature is very obvious; it is for easy after-washing. (From annual report of commissioner for Madras, 1881.)

AN INDIAN SANITARY COMMISSIONER REGARDS CHOLERA AS ONLY A PERNICIOUS FORM OF  
MALARIA, AND REPUDIATES THE WATER THEORY.

*Water theory.*—Regarding the water contamination theory the army sanitary commission says: There is no proof that impure water has exercised any specific influence on the production or propagation of cholera in India, although in India as elsewhere water containing animalized matter in a state of putrescence, whether proceeding from healthy or choleraic discharges, may act as a predisposing condition when cholera is present in a locality. Existing putrescence appears to be the element required, and not any supposed specific poison; hence impure water sources might be innocuous if the decomposition of organic matter were complete and only nitrates remained, but almost poisonous if drunk while putrescence was in progress. (From annual report of sanitary commissioner for Bombay, 1884.)

*Cholera and malaria.*—In my opinion cholera will in time be recognized as an intensified form of the malarial fevers common to the country. Medical authorities say it is almost impossible to diagnose between it and pernicious intermittent fever, and the symptoms described in the latter are similar to those seen in cholera. Drs. Lewis and Cunningham, although they do not admit that the causes productive of cholera and malarial fevers are identical, yet point out the marked parallelism which exists between these diseases. (From annual report of sanitary commissioner for Bombay, 1884.)

But the water question, simple as it looks on paper, is a very difficult one to deal with. The dirtiest tanks in Southern India are many of them the holiest and most sacred, to which crowds of pilgrims resort on certain high feasts and festivals to bathe and wash away their sins. These places, many of which have not been cleaned out in the memory of man, have a reputation such as was enjoyed of old by the pools in India. In this "Teppa Kolam," you are gravely informed, a certain Rajah bathed and was cured of leprosy; hundreds of barren women have become happy mothers from washing therein; people possessed of evil spirits after dipping have been restored to their senses, etc. It is no use arguing against these "facts"; they are presented to us with the irresistible force of tradition and firm religious belief, and one must, even if not agreeing, at any rate treat with respect beliefs which are or have been common in all ages. But still I think I perceive that many Brahmin gentlemen, vice-presidents and others, not priests, are inclined to admit that perhaps the miraculous virtues of these holy tanks would not be destroyed if they were periodically cleaned out and allowed to become filled with pure water.

#### WATER SUPPLY OF PONDICHERRY.

During December, 1882, the sanitary commissioner for Madras visited, with the permission of Government, the French settlement of Pondicherry to examine the system of artesian wells there. The following is the memorandum which he forwarded to his Government on the subject:

My object in visiting this French settlement was to make myself acquainted with the artesian-well water supply, and to ascertain how far the inhabitants of this town had or had not escaped the epidemic of cholera which swept over Southern India during the end of 1881 and commencement of 1882. A full description of these wells (as far as they then existed) is given in various Government orders marginally noted, but more especially that of March 31, 1881, No. 548, revenue department.

To a sanitary commissioner the interest of such a water supply lies, of course, mainly in its effects on the health of a community and the freedom it may bring it from epidemics of cholera and typhoid fever. The question of irrigation does not, except indirectly, concern him.

*Number of wells in Pondicherry.*—There are now a number of artesian wells (14) scattered over the town of Pondicherry and its neighborhood. In Mr. King's report, May 20, 1880, four or five are described. I saw four in one compound alone, that of the Savana Filature, another in the Jardin d'Acclimatation, another in Colonel Sherman's garden, and one in course of construction, and in many different parts of Pondicherry fountains, with water laid on from these wells, pour forth an ample supply of pure, clear water for the use of the inhabitants.

*Nature of water.*—I have tasted the water at the different sources; it is warm, clear, with a distinctly ferruginous taste. It is used by the natives for cooking and drinking, and its slightly ferruginous taste comes to be liked after a short time. It is in high repute medicinally; skin affections are said to disappear under its use, and many natives of respectability come from English territories to drink the water for diabetes. Indeed, lately at Madura I met a highly intelligent Brahmin gentleman, who informed me he had been residing in Pondicherry for some time to drink these waters for an affection of the kidneys, and had derived much benefit therefrom.

*Pondicherry during the late cholera epidemic.*—I visited the general hospital at Pondicherry to make inquiries about the late cholera epidemic, naturally thinking I should there



find official records on the subject. The *médecin-en-chef*, Dr. Quetand, had not heard of any cases of cholera. The native doctor of whom he inquired had heard of a few in the outlying districts, but there had been none in the town. A few cases had been imported into Villanour, an outlying suburb, but it had not spread. "You see, Monsieur, we have such good water," was his remark.

*Remarks.*—I have frequently remarked, but I can not help again repeating it, that an improved water supply is the great sanitary need of our Indian municipal towns. Until the frightful water contamination which at present obtains is overcome all our other efforts are almost nugatory. We have such large towns as Tanjore, Trichinopoly, Madura, Negapatam, Berhampore, and others, with little or no clean water for domestic purposes. The greater number of people drink and cook with what in Europe would be called sewage. I am not exaggerating when I use the term sewage. Here, not in our territories, but close to us, is a city not so rich, perhaps, as any I have mentioned above, with an ample supply of good water available to the poorest, and which the people can not defile. It may be said of Pondicherry, as it is said of Rome: "Its principal wealth lies in its magnificent water supply." I think it would be well if the question were taken up again, and the Negapatam municipality, taking heart from the great success of artesian boring at Pondicherry, were to engage the services of some one practically acquainted with the process to construct an artesian well for it.

I may here briefly recapitulate the impressions left upon my mind from the visit. We have presented to us a town, furnished with what must be considered the most essential necessary of a tropical city—an ample supply of clean water. There are no less than fourteen artesian wells in the place, some ten of which belong to the public. There is, besides, a supply of water conducted from a distance and laid on with pipes in the city. In every street you see hydrants with stop-cocks, from which the people draw water; there are no tanks.

Cholera during 1881-'82 and commencement of this year, 1883, has twice swept past Pondicherry, playing sad havoc in the towns of South Arcot, contiguous to the French territory, viz, Cuddalore, Porto Novo, Villupuram, Chidambaram, Negapatam, etc., and yet has never effected a lodgment in Pondicherry. It has also visited the towns lying on the same littoral, and apparently enjoying the same localistic influences.

It may be possible for those who entirely disbelieve in the water contamination theory to account for this on other grounds, but certainly at first sight it seems difficult. The evidence, although striking, is, I am aware, not conclusive, but at any rate it adds one more to the many accumulating facts on this interesting question.

It is a matter of congratulation that many of our municipalities are bestirring themselves energetically in the question of a pure water supply, and that some, noticeably Negapatam, are apportioning a part of the revenue to construct artesian wells. (From annual report of sanitary commission for Madras, 1882.)

#### *CHOLERA IN RELATION TO WATER SUPPLY IN SOUTHERN INDIA.\**

The question which concerns us as practical medical men, especially in India, is this: Can anything be done to prevent these constantly recurring epidemics of cholera? I answer, yes. The remedy lies in the hands of the authorities if they will but have the courage to use it, and it is this: to provide the people with a pure and uncontaminated water supply. In this, which in no way militates against or interferes with general sanitary improvements, lies, it seems to me, our safe-guard, at any rate in Southern India, against these constantly recurring epidemics of cholera (I say Southern India because I have no desire to intrude on the domains of sanitarians in Upper India.) During the last 5 years it has been my duty to visit all parts of our presidency, and shortly after I became sanitary commissioner I was struck with a fact which,

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\*Surg. Gen. M. C. Furnell, M. D., Madras, India Medical Gazette, April, 1886. Dr. Furnell is almost the only high sanitary official who dared, during the official term of Dr. Cunningham as surgeon general and sanitary commissioner with the Government of India, to openly advocate and publish the opinion that cholera is conveyable, and chiefly so by the water supply. On account of the pressure brought to bear upon this conscientious and courageous sanitarian, in order to stop his open discussion of this exceedingly important question, a question was not long ago addressed in Parliament to the Secretary for India. In this connection consult Koch on Censorship in India.

although patent and before my eyes every day during the previous 25 years of my service, had never, simply because I suppose it was not my business, attracted my particular attention. And it is this: Every hamlet, village, and town in Southern India—and it is more or less the case all over this immense continent—has a water supply open and easily open to the foulest contamination. As you are aware, the usual water supply of every place is a large open tank, one or more, according to the size of the place. In these tanks the inhabitants proceed to wash their persons after obeying the calls of nature; wash their dirty clothes—often clothes taken from patients that have died of cholera—and take home bright chatties of the water thus sullied as drinking and cooking water to their homes. Now, supposing water is an agent when contaminated with the cholera contagium (I use the word “contagium,” condemned as it is by a high authority in this country, for want of a better) in spreading cholera, we see at once that the habits of the people favor in every way its spread.

Then comes the question, or, rather, two questions arise:

(1) Have we any proof that water contaminated with cholera dejecta will spread cholera?

(2) Have we any proof that a people supplied with a pure and uncontaminated water supply escape cholera?

I myself can not understand how any one, at any rate any one in our profession, can have any doubt as to what answer should be given to the first question. The famous Broad street case, so lucidly reported by Snow 30 years ago, ought, one would imagine, to have settled the question forever; but since then an immense amount of evidence has been accumulating, especially in Europe and America, on this point. The only reason for skepticism lies, I fancy, in the fact that the evidence is buried in an immensely scattered literature. No one seems, as far as I can ascertain, to have brought the evidence together in a concrete form. I have during the past year attempted to do so for my own information and by the kindness of Government I hope to be able shortly to lay it before the profession in a printed state. It would take up too much time for me to answer at length the first question this evening, as I wish to confine my remarks more especially towards answering the second question, but I will mention two very singular cases on this point, not generally known, which have passed under my observation.

Salem, the capital of the collectorate of the same name, has had for many years past a most unenviable notoriety for cholera epidemics. If cholera appears in Southern India, Salem is almost sure to suffer. The water supply, presuming always that water plays a role in these epidemics, is such as to favor in every possible way this spread of cholera. The town is bisected by a small shallow stream, a roaring cataract during rainy weather, a series of shallow puddles, scarcely flowing, in dry weather, which, as we know, is by far the longest period of the year. In this stream the Brahmins and Hindoos of caste wash their bodies, clothes, and from it take home bright chatties of the fluid to drink and cook with. Musselmen and non-caste people are not allowed to touch this stream, for it is sacred. It is consecrated to Vishnu. Now, a curious circumstance has been noticed in these epidemics of cholera at Salem, that it falls with much greater severity on the Brahmins and caste Hindoos, who use this water, than on any other portion of the community. This was particularly noticed in the epidemic of 1881, when the Brahmins and caste people suffered very severely. The Europeans lost not one person (but of course they are compared with the others very few in number). The Musselmen lost a few cases, but, most curious of all, the Chucklers and Pariahs lost not one person, although these last are, as we know from the nature of their occupation, an uncleanly people. But then they are strictly forbidden to come near the stream; lest they should pollute it, and they draw their water from wells.

Moreover, Mr. Stokes, the collector, a man of great energy and intelligence, on his own responsibility, took means suddenly to prevent the Hindoos from taking water home from the river. This step was followed by an immediate diminution of mortality. The people, with their usual gratitude, subsequently sent in petitions to Government against the collector, complaining of his high-handed encroachment on their rights.

Cuddapah, or a suburb of it, suffered from cholera in 1883, and here again a curious circumstance, pointing to impure water as the cause, manifested itself. The cholera was in the



hamlet of Yerranukapalli, through which flows the small stream, the Bogra ; this, like most streams in Southern India, is a swift-flowing river in the monsoon, a series of sluggish, scarcely moving puddles in the hot season. Cholera broke out when the stream was sluggish, and here again was confined to the Sudras, a caste people living on the banks of the river and using its water for every purpose. Curiously enough just across the main road within 20 yards is a hamlet inhabited by Malahs (pariahs); amongst these not one case of cholera, occurred; but then mark, they are not allowed by the Sudras to use the sacred stream, and are obliged to draw their water from a large well, which happily they possess. There was additional evidence concerning this stream : a little way above the village is the place where the dhobies wash the clothes, and it was discovered that previous to the outbreak of cholera in Yerranukapalli clothes of cholera patients from a neighboring village had been washed in the river above. This may be called by some a "mere coincidence," but I confess I prefer the plainer and more obvious inference that a contaminated water supply is an important factor in the spread of cholera.

I could multiply these cases from facts which have come under my knowledge in this presidency during my tenure of office as sanitary commissioner, but the limits at my disposal this evening forbid my doing so.

I will proceed to the second question.

(2) Have we any proof that a people enjoying a pure and uncontaminated water supply escape cholera ?

The evidence on this point amounts to nothing more than circumstantial evidence, but I think it is circumstantial evidence of a very convincing kind. Exact evidence, unless we proceed to experiments which humanity is said to forbid, is almost impossible to produce in a question of this sort.

We will first take our own presidency, which contains a few, alas too few, cases in point.

There is Guntur, in the Kistna collectorate. For many years this place was, like Salem, famous for cholera epidemics, a sort of head center of cholera whenever cholera appeared in the ceded districts ; since 1868 it has enjoyed a singular immunity, so much so that Government called for a special report on the subject, and this is to be found in the sanitary commissioner's report for 1879. Suffice it to say that since 1868 the town of Guntur has been free from cholera even when cholera was raging in the district around ; and what is the reason ? I consider it is owing to its improved water supply. Dr. Bigg Wither, who first took its conservancy in hand, certainly paid attention to all its wants. Here is what his successor, Dr. Tyrell, writes :

"In pre-municipal days simple sanitary laws were ignored by the natives, who detest sanitary officers and sanitary measures. It is mentioned that 'local sanitary improvements, so far as yet known, are the only real safe-guards against epidemic diseases.' Now, let me just mention what these have been in the town since it was brought under municipal laws.

"*First*, as regards the soil. The surface of the soil was everywhere in pre-municipal times polluted daily by filth and rubbish of all kinds, which were allowed to accumulate in the court-yards of houses, in open spaces, and by the sides of the streets, lanes, and by-lanes of the town. With this filth there was certainly a good deal of fæcal matter mixed up, and this fæcal matter in seasons when cholera was prevalent would contain the special poison or germ which is supposed to develop it, and which would be diffused by being exposed to the influence of winds throughout the town. The subsoil all over the town was also polluted with fæcal matters, which were deposited by the people in the numerous privies, which were only occasionally, I believe, cleaned out by letting pigs run into them to eat up the excrement. Scavengers were in those days unknown in the town, and hence those who now and then cleaned their privies sought the assistance of the pigs, of which, I am told, great numbers existed here belonging to the Wudder people.

"*Secondly*. Then the houses occupied by the inhabitants were never cleaned or whitewashed, as is done now once a year under municipal regulations. The chattrams in the town, to which travelers from all parts of the country and pilgrims from Juggernaut and Pooree to Ramas-

varam resorted, were always kept in an extremely filthy condition, and their court-yards contained filth of all imaginable kinds. Now-a-days these chattrams are lime-washed as often as thought necessary by the sanitary officer, and no filth is allowed to be kept in the court-yards.

*“Thirdly.* The conservancy of the streets, lanes, and by-lanes, and of all open spaces in the town is now regularly attended to by the scavengers employed by the municipality. There was no conservancy in pre-municipal days, and filth was allowed to remain until washed away by a heavy fall of rain. There was no conservancy of court-yards then as now, for nothing noxious can be kept by the people in them, as the conservancy overseer inspects them daily to see if they are kept clean. If filth be found in them, the owner is directed by notice to remove it at once.

*“Fourthly.* Formerly prickly-pear and croton plants were found in every part of the town, and especially in the outskirts. Into them filth of all kinds was thrown, and they favored the commission of sanitary nuisances, for people flocked to their neighborhood to answer the calls of nature. At present no prickly-pear bushes or clumps of croton are found anywhere about the town within municipal limits, to afford shelter for the commission of such offenses.

*“Fifthly.* No attention in those days was paid to keep the water in the tanks, reservoirs, and wells clean. When I came here in December, 1870, I was astonished to see the natives polluting the water supply everywhere, but particularly in the reservoirs. Here were people washing their mouths of a morning, spitting the foul water out of them into the reservoir, washing their soiled clothes, bathing their persons, and doing other dirty acts which the authorities ought not to have allowed. The tank banks in the wet and the beds in the dry weather were converted into privies by people of all classes—the intelligent Brahmin, the ignorant Pariah, the Government official, and the poor cooly were all found defecating on the banks and beds of the tanks which supplied their reservoirs with drinking water. Most of the wells in the town had no parapet walls, and, as the natives, especially Komatee and Brahmin women, resorted to them for bathing and washing their soiled linen, all the impurities contained on their persons and in their foul clothing were carried back into the well with the spilled water. During the prevalence of cholera cloths stained with cholera discharges were no doubt washed here, and the water thus poisoned was drunk by thousands. At present the reservoirs and tanks are watched by men appointed by the municipality to see that no pollutions of the kind enumerated are made by the people who resort to them for water. All the public wells, with one or two exceptions, are provided with parapet walls, platforms, and posts, with wheels to facilitate drawing of water. Most of the wells within private compounds are also similarly protected.

*“Sixthly.* The food supply of the people is regularly inspected by a servant of the municipality, so the eatables that are found to be unfit for human consumption are not allowed to be sold, but destroyed at once. This was not done in pre-municipal days, when the Komatee bazaarmen sold unsound articles of consumption.

“Cholera has prevailed on some occasions in the neighboring villages, but no case occurred in the town. Even during the famine, when it was prevalent throughout the districts in the villages close to Guntur, and also in the famine relief-camp, situated two miles to the north of it, there was no case developed in the town. I have been here since December, 1870 (except for the time from October, 1877, to May, 1879, when I was at Bunder and on furlough to England), and I am prepared to state that during the time I have been in charge of it as medical and sanitary officer I have not known of the occurrence of a single case of cholera.

“Now, the question that one would be naturally inclined to ask is, why the town, which of yore was frequently visited by cholera, should since the introduction of municipal laws and regulations based on sanitary principles be free from it?

“The answer is that to the changes which have been effected in the sanitary condition of the town must be attributed the immunity which the town has enjoyed from attacks of the disease. I know of no other causes at work than those I have enumerated to which this freedom can be ascribed.



"In pre-municipal days the town was in a highly insanitary condition, when there was everything to favor the development and spread of cholera once it was introduced by the methods mentioned in the reports of medical officers already copied.

"Since those wholesome laws and regulations have been brought into operation the condition of the town has been, in a sanitary point of view, considerably improved, and all disease-generating causes have been removed and are being removed as detected without being allowed to remain and become the centers from which diseases of an epidemic nature may develop and spread. All my endeavors as sanitary officer have been and shall be directed to maintain this town in as good a sanitary state as I can by removing all those conditions which led to insanitation, and favor the development of epidemics, and thus far, under God's blessing, the health of this town has been, I am pleased to report, remarkably good."

But, as we all know, the moment an energetic, conservative officer of the stamp of Dr. Tyrrell withdraws his hand, things soon fall back into their primitive state. I will not say the general conservancy of Guntur is as bad as when Dr. Bigg Wither first took it in hand, but I will say Guntur is no cleaner generally than many towns in India, indeed not so clean as many I could mention in our presidency, so its immunity from cholera can scarcely be owing to general sanitary arrangements. But it has an admirably arranged water-supply, an arrangement which I should like to see carried out in every town where it is possible. Some little distance out of the town is a fine, large tank, almost a small lake, and from this the water, having first been allowed to run through a large roughly constructed but effective filter, is passed by pipes into the town, and distributed to the inhabitants at various stands. The tank itself is zealously conserved; its banks are patrolled by peons who rigorously defend it from being polluted by dhobies or people washing themselves therein. To this I consider Guntur owes its immunity from cholera since the time of Dr. Tyrrell, but I should not be astonished at any time to hear of a sudden outbreak of cholera in Guntur. Let the strict watch over the tank be relaxed; let a party of pilgrims encamp on the banks, and use it as pilgrims with cholera amongst them invariably use a tank, and Guntur will lose its present reputation. A water-supply to be safe should be beyond the reach of contamination by pilgrims and wayfarers.

Such a water-supply is presented to us at Pondicherry. Now Pondicherry has a singular immunity from cholera, even whilst cholera is raging in the neighboring English towns, Cuddalore, Chellumbrum, etc., of the South Arcot district. By Pondicherry, I mean the town proper of Pondicherry, not the district, for in that cholera has of late made its appearance. Pondicherry town is supplied with water by artesian wells, and also from a small lake (Montirepoleon), situated some distance outside the town, from whence the water is led in by pipes and distributed throughout the town. It is, of course, impossible to contaminate the source of an artesian well, and great care is taken that the other source is also protected. Now, as I said above, Pondicherry escapes, and has for years escaped cholera, even while it was raging in neighboring English districts. I attribute this entirely to its unique water-supply. If it is argued it is more likely owing to its general cleanliness and conservancy, I answer that whilst all must admit Pondicherry is a clean town, in that respect an example, still I can not admit it is so much cleaner than the neighboring English town Cuddalore, where cholera flourishes with much vigor; nor can I admit the difference is owing to telluric, atmospheric, or local influences, for, to tell the truth, these terms convey no very definite ideas to my mind, and seem rather a convenient escape from ignorance than any scientific explanation. But why, one may ask, should a certain spot in a contaminated district thus suddenly be exempt from these mysterious influences? Its unique water-supply, free from contamination, seems to me a much more common sense explanation of the matter.

Let us turn to Madras itself, I mean our presidency town. The diminution in the number of deaths from cholera since the Red Hills tank supply has been available is very remarkable. I have prepared a table from the sanitary commissioner's office which shows this very well.

Years.	Deaths.	Years.	Deaths.	Years.	Deaths.
1855.....	1,956	1865.....	944	1875+.....	879
1856.....	805	1866.....	2,984	1876†.....	2,035
1857.....	1,378	1867.....	614	1877†.....	6,246
1858.....	1,965	1868.....	13	1878.....	64
1859.....	1,082	1869.....	568	1879.....	34
1860.....	2,580	1870.....	861	1880.....	2
1861.....	2,776	1871.....	493	1881†.....	123
1862.....	3,635	1872*.....	5	1882†.....	361
1863.....	1,684	1873.....	6	1883†.....	168
1864.....	574	1874.....	0	1884†.....	269

\* Red Hills water, supply opened.

† Famine years.

‡ A very severe epidemic throughout the presidency.

The Red Hills water supply was opened in 1872, and it will be seen the drop in deaths from cholera was immediate, and persisted during 1873 and 1874. This, I take it, however, was somewhat accidental and not altogether owing to an improved water supply. There was during those years a general absence of cholera in the Madras presidency. Then came the terrible years of the famine, 1875, 1876, 1877, when, as we know, people flocked into Madras from the neighboring districts, many of them simply to lie down and die, and most deaths, to save trouble, were registered as cholera. Then, during 1878, 1879, and 1880, we have very few deaths, if we contrast their figures with the previous returns from 1855 to 1871. Then came the years 1881, 1882, 1883, and 1884, to my mind the most encouraging of all, for during these years we had one of the severest epidemics of cholera in this presidency on record, and yet the deaths are comparatively few. Contrast these deaths with those from 1861 to 1864. Moreover, it was found on inquiry, for I took great pains in the matter, that the deaths which made up even these insignificant figures, came from the outlying districts of Madras, where Red Hills water was not laid on Tondiarpettah, Washermanpettah, Royapuram, and Casse-mode. And Madras would have still a cleaner bill of health from cholera if a number of old tanks, dirty, but popular from long accustomed use, were closed.

Dr. Townsend, late sanitary commissioner for the Punjab, whose views concerning cholera and water coincide with mine, sent me lately from England the following instructive table of the deaths from cholera in the city of Nagpur for 7 years previous and 7 years subsequent to the introduction of water from the Ambaghiri reservoir.

[Population of city, 84,500.]

Year.	Deaths.	Year.	Deaths.	Year.	Deaths.
1865.....	420	1871.....	4	1877.....	3
1866.....	387	1872*.....	23	1878.....	69
1867.....	0	1873.....	0	1879.....	12
1868.....	44	1874.....	0	1880.....	0
1869.....	412	1875+.....	32	1881.....	60
1870.....	1	1876+.....	61		

\* Water from Ambaghiri let on.

† Deaths occurred in a section of the city where Ambaghiri water has not extended.

Here is what Dr. Townsend writes :

“The number of deaths from cholera in the city during the seven years subsequent to the introduction of pure water is less than one-seventh of the number recorded in the seven years prior to that event (177 against 1,264). Epidemic outbreaks of cholera may be said to have ceased to occur in the city, or at any rate are limited to certain sections *in which open tanks exist*. In many of the cases that occur in the city when cholera is epidemic over the country, the disease has been contracted outside.

“Systematic conservancy, *i. e.*, the removal of filth daily from the city, was instituted in 1866, but no comprehensive scheme of sewerage or drainage has been carried out. The water



service extends to 20 of the 26 circles into which the city and station are divided. The better classes in some of the remaining circles fetch the Ambaghiri water for use, but the poorer classes depend upon tanks or wells sunk at the edge of the tanks, and it is in these circles that the deaths from cholera that appear in the city register chiefly occur. Of the 60 deaths from cholera registered in 1881, 31 occurred in one of these circles, leaving only 29 distributed over the remaining 25 circles.

"It will be observed that whilst the mortality from cholera has greatly decreased in the city of Nagpur, there has been no diminution in the district; on the contrary, epidemics have of late years been frequent and severe."

The literature of Europe is amply supplied with facts showing that a pure and uncontaminated water supply confers an immunity from cholera. It would be impossible in the short time at my disposal to quote one-tenth of the extracts I have accumulated on this point, but I may draw attention to one or two of the most remarkable.

In a late number of the *Nineteenth Century* (viz, that for August, 1883) there will be found a very interesting paper from the pen of Professor Frankland. In this communication the writer points out how London has suffered from cholera on four different occasions, viz, 1839, 1849, 1854, and 1866, and that these epidemics, although more or less severe, had some very striking and instructive differences. The mortality in 1832, was undoubtedly great, but at that time there was no official registration of the causes of death. According to information received, however, the privy council put down the number of deaths as 5,275; taking the population of that time these figures represented a mortality of 36.4 per 10,000.

In 1842 the deaths attributed to cholera in the metropolis amounted to 14,137, or 61.8 per 10,000, in 1854 there were 10,738 victims, or 42.9 per 10,000, whilst in 1866 cholera was fatal to 5,596 persons, or 18.4 per 10,000 of the inhabitants.

This diversity in the mortality during different epidemics is thus accounted for:

In 1832 a considerable part of London was supplied with water abstracted from the Thames and the Lea, the remainder being obtained from shallow wells.

At that time the river water within the metropolis can not have been nearly so much polluted as subsequently, owing partly to the smaller population of their banks, but chiefly to the absence of an efficient system of sewerage in the metropolis. In 1849 the sources of water supply remained substantially the same, except that the river water had probably taken more and more the place of the shallow well water. In the meantime, however, the sewerage system had become fully developed in London. The drainage of nearly the whole population was thus rapidly conveyed into the three rivers from which the water supply of London was drawn, namely, the Thames, the Lea, and the Ravensbourne. The rivers became proportionately fouled before distribution. *In fact, at this time the water companies rapidly restored to the inhabitants of London the drainage matters which the sewers had discharged.*

It was in this epidemic (1849) that London suffered most severely, the mortality from cholera amounting to nearly 62 per 10,000 of the inhabitants. On examining the mortality more in detail we find on the evidence of the late Dr. Farr, medical adviser to the registrar-general, that amongst the population supplied with the water taken from the Thames, at Kew, cholera was fatal to 8 in 10,000 of the inhabitants, while in the districts supplied with the water taken from the river at Hammersmith it was fatal to 17 in 10,000, and again in the population supplied with water abstracted from the river below Chelsea Hospital it was fatal to 47 in 10,000, while the districts drawing their supply still lower down, viz, at Battersea, and between Hungerford and Waterloo Bridges, where the river was still more foul, suffered to the extent of 163 deaths per 10,000 inhabitants. Before the next visitation, in 1854, a small portion of the water abstracted from the Thames within the metropolis had been replaced by a corresponding volume taken from the river above Teddington Lock, and consequently beyond the reach of the London sewage. Corresponding to this improvement in the water supply we find a reduction in the mortality from cholera, which in the subsequent epidemic of 1854 was only 43 per 10,000, although in the same epidemic we find that in those districts still supplied with the foul water below Teddington Lock the mortality was actually greater than

in 1849. Thus on the south side of the river the two great competing water companies are the Lambeth company on the one hand and the Southwark and Vauxhall companies on the other. Of these two companies in 1854 the Southwark and Vauxhall still pumped from the Thames at Battersea, whilst the Lambeth had removed their pumping station to Ditton, above Teddington Lock. The houses supplied by these two companies were in the same district, pipes of the two companies interlacing and sometimes running parallel in the same street, so that, excepting as regards the water supply, the conditions affecting health in the two sets of houses may be safely assumed to have been identical; but whereas the mortality amongst the population supplied with the comparatively pure water of the Lambeth company was only 40 per 10,000, that of the population supplied with the foul water of the Southwark company was 130 per 10,000 of the inhabitants.

In the last epidemic, which occurred in 1866, all the companies drawing from the Thames had fortunately removed their intakes to points above Teddington Lock, and corresponding to this improvement we find that the mortality fell in this epidemic to 18 per 10,000 inhabitants.

It is, however, in this epidemic that, perhaps, the most striking evidence of the effects of drinking water is to be obtained.

In this year certain parts of the east end of London suffered most severely from cholera. These parts of London were in the area of one water company, and what makes the case more remarkable and conclusive is that not the whole area of that water company suffered. The water company gave two waters, and the high cholera mortality was apparently restricted to those parts of London which received one of those supplies to half the district, so to speak, of the East London Company. The source from which this company supplied this half of the district was a source peculiarly exposed to contamination from a foul part of the Lea.

On August 1 of that year, 1866, the registrar-general gave notice to the East London Company of the danger of distributing this polluted water supply, and from the day they discontinued the intensity of the disease began to abate, and within the month the number of deaths from cholera was less in the east end than in other parts of London.

During the past year M. le Dr. Marey, a member of the Institute of the Academy of Medicine in Paris, professor in the College of France, has published a pamphlet, "*Les eaux contaminées et le choléra*," in which the same facts as shown in the article quoted above, viz. that in Paris the intensity of cholera was in exact proportion to the contaminated water supply, are very clearly brought out. He shows by a map that cholera was very heavy in Paris on the right side of the river Seine, and very light, almost infinitesimal, on the left. The part of Paris which suffered heavily from cholera was supplied with water from the rivers Seine and Ourcq, into which rivers the sewers of Paris empty themselves. Here we have exactly the same state of things as occurred in London in 1849; "the water rapidly restored to the inhabitants the drainage matters which the sewers had discharged."

The part of Paris which escaped the cholera was supplied with water by the wells of Grenelle, "proceeding from a deep spring sheltered from all filth, which," remarks Dr. Marey, "well explained the immunity enjoyed by the inhabitants who drew their water supply from this source."

Quite lately a very singular instance of the protection afforded to a community by a pure and uncontaminated water supply has been brought to my notice by Dr. Van Geyzel, acting district surgeon, Ganjam. Cholera after having raged with considerable fury in the southern part of our presidency crossed the railway and slowly made its way northward, following the course of the Buckingham Canal. It reached the Ganjam collectorate and created more or less havoc in the district, but to quote Dr. Van Geyzel's own words:

"The port of Gopaulpore (Ganjam district) has enjoyed a remarkable immunity from epidemic cholera under circumstances which are sometimes considered very favorable to the spread of the disease.

"Cholera has this year (1885) raged all over the district from Rumbha to Chicacole, and from east to west; the villages in the neighborhood of Gopaulpore furnished not a small proportion of cases. When it is remembered that from these very villages hundreds of coolies go daily to Gopaulpore for work and back again, that a stream of carts (about 150 on an average)



keeps daily pouring into Gopaulpore from various parts of the district and out again, it goes without saying that Gopaulpore is by no means isolated in any way, but that, on the contrary, it has as frequent and large a communication with the interior parts of the district as Aska or Rumbha, or even Berhampore, in all of which places it may be said that cholera is very seldom absent.

"During this year only 3 cases of cholera occurred in Gopaulpore. These cases arrived already suffering from the disease. In this way the disease has occurred now and again, chiefly among people coming from other places; but it has not gained a foothold.

"The general sanitary condition of Gopaulpore, though much improved of late, is by no means what is to be desired. There is, however, one circumstance which makes Gopaulpore unique in respect of its water supply: *It has absolutely no tanks whatever.* There are 35 wells in the village for a population of 2,675 people, good, bad, and indifferent. Lately some good wells have been sunk by Mr. Minchin, who generously allows people to take drinking-water from them, and they are freely resorted to.

"The immunity of Gopaulpore from epidemics of cholera while it was surrounded by infected villages with which abundant daily communication took place, as well as with other and more remote parts of the district, especially at a time when cholera was raging epidemically generally over the whole district, and the inability of the disease to establish itself, although it was imported on many occasions, point to the want of something by which the disease could be propagated and spread. In this connection the absolute absence of tanks is well worthy of note."

Now, what is the remedy for these recurring epidemics of cholera? If what I have read above is true, if the facts stated are facts, the remedy seems very obvious. Provide the people with a pure and uncontaminated water supply for drinking and domestic purposes.

At first glance it may seem an almost impossible task to insure so large a population as Southern India pure water. It is a "big affair," but not more considerable than many other blessings which have been conferred by a beneficent government on the people of this country, such as "justice," "police," etc. What has been done in one place as regards water—say "Guntur" or "Nagpur"—can surely be repeated, say, in "Tinnevely," "Bellary," and so on until all towns are protected. All India is but the repetition of the unit, the "village community."

In a report sent by me as sanitary commissioner on cholera in the Tanjore district, G. O., August 28, 1881, I drew attention to this matter, and I will here repeat what I wrote:

I would propose that in every one of these villages a good deep well be sunk, properly made of brick-work and masonry with parapet, sloping sides, etc., under the superintendence of the local fund engineer; in some of the larger and more wealthy villages one or two wells might be constructed. I think the people, as at Negapatam, would come to see the greater advantages of drawing water from such sources to being dependent upon tanks. I would even go a step further, and in some of the larger villages I would have a pump to raise the water into reservoirs, from which it might be drawn by stop-cocks, as is being done in Madura and is to be adopted in Negapatam. The use of small pumps to raise water into reservoirs is common at many stations of the South India Railway. This not only saves much labor, but keeps the well from a possibility of being defiled by dirty ropes and chatties.

The use of driven tube wells, commonly called 'Abyssinian wells,' is worthy of consideration. It would make this paper too lengthy to go into details, but from a small work on the subject, lately published by Mr. John Scott (Irrigation and Water Supply, London, Crosby Lockwood & Co.), it would seem they are now the form of wells most commonly sunk in many parts of England, and are not expensive.

What obtains in Tanjore obtains throughout the presidency; the amount set aside for the improvement of water-supply is never spent. No systematic attempt has yet been made to remedy the water supply.

Nor is there anything repugnant to the religious prejudices of the people in thus improving their water supplies. On the contrary, as I have pointed out elsewhere, to keep their drinking water free from contamination is a religious duty strictly enjoined on all Hindus in

their ancient shastras, and, as far as I have been able to gather in my various tours in the presidency, the importance of this duty is fully admitted and recognized by all respectable natives.

Although I feel as sure as I can feel sure of anything that a pure and uncontaminated water supply would considerably diminish and in time practically abolish the enormous mortality of these cholera epidemics, yet if we are wrong and it did not, if the scheme fell short of our (or my) expectations, no harm would be done, no useless expense incurred. All sanitarians are agreed that a pure water supply is, especially in tropical climates, the greatest boon that can be conferred on a community.

The Government is most benevolently inclined toward the millions committed to its charge. I have felt it my duty as sanitary commissioner over and over again to draw their attention to this matter of water supply, and I have always had the most cordial support and encouragement. But the matter rests now mainly in the hands of local fund boards and municipalities, who are apt to think they have no funds to spare for this most necessary sanitary improvement. It becomes necessary for medical and sanitary officers to be persistent, in season and out of season, in their endeavors to bring it about. If the scientific and medical world of Europe come to indorse Burdon Sanderson's lately expressed opinion that every epidemic of cholera which reaches Europe has its starting-point in the home of some Hindu on the bank of the Ganges, they will presently take India to task as to what it has done to stamp out this disease. General sanitary arrangements are all very well and have my most cordial support, but I don't think they will ward off cholera any more than they will set a broken leg. A man with a fractured limb is none the worse for having his house whitewashed and the general sanitary arrangements of his surroundings attended to, but a sensible practitioner will scarcely expect a satisfactory union unless he applies splints. So with cholera, whitewash the houses and clean up generally by all means; but if the water supply is contaminated or open to contamination the inhabitants of the whitewashed houses are not safe. Such at least, gentlemen, is my humble opinion after some forty years' experience of this dread scourge.

#### WATER SUPPLY IN NAGPUR.

[Gaffky, German Commission Report, p. 239.]

A further example of the influence of the water supply upon cholera in India is furnished by the 85,000 inhabitants of the city of Nagpur, the capital or chief city of the Central Provinces. According to a communication of the former sanitary commissioner for the Punjab (Compare Furnel, *Indian Medical Gazette*, April, 1887), the city was supplied in 1882 from the "Ambaghiri reservoir." In the seven years previous to the opening of this water supply there were 1,264 deaths from cholera; whilst in the next seven years after that date Nagpur had only 177 deaths from the disease, which was only about the seventh part of the former figure.

It has been further remarked in Nagpur that after the opening of the water supply the cholera was limited almost exclusively to that part of the city in which impure water was still used, such as that of surface streams and open tanks.

The number of deaths in this city from cholera from 1865 to 1881 is shown in the following table:

Year.	Deaths.	Year.	Deaths.	Year.	Deaths.
1865.....	420	1871.....	4	1877.....	3
1866.....	387	1872*.....	23	1878.....	69
1867.....		1873.....		1879.....	12
1868.....	44	1874.....		1880.....	
1869.....	412	1875.....	32	1881.....	60
1870.....	1	1876.....	61		

\* Opening of the water supply.



Of the 60 deaths in 1881 not less than 31 belonged to a part of the city which had not the water supply, and where especially tank water was used; the remaining 29 deaths were distributed among the remaining 25 districts of the city, of which 20 had the water supply, whilst the inhabitants of the 5 others made use of the streams or tanks and only made a partial use of the water supply of neighboring districts which had it.

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#### MILK CONTAMINATION.

In illustration of the possibility of the contamination of milk, I may mention Goalatolla, opposite Manicktolla, in Calcutta. The tanks on the sides of which the cow-huts are built are simply full of masses of cow dung. An owner of cows acknowledged to me that he put one-fourth of water to three-fourths milk and considered it a fair proportion, and that any excess of water beyond this was not so, and that before the hydrant water was brought so near to him he used to use the tank filth then in front of us to dilute the milk. Arrangements have, however, been made for the clearing away regularly of all this cow dung. (From section IX, sanitary works, annual report of the sanitary commissioner for Bengal, 1879.)

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#### CHOLERA AND MILK.

By Dr. W. J. SIMPSON, HEALTH OFFICER OF CALCUTTA.\*

An instructive example of the facility with which milk may become the medium for the propagation of zymotic diseases is afforded by a limited epidemic of cholera which occurred on board the sailing ship *The Ardencluta*, lying in the port of Calcutta. Dr. Simpson, the health officer of Calcutta, investigated the outbreak with great care, and in a most admirable report, published in the Indian Medical Gazette, offers strong evidence that the outbreak was not to be traced to any peculiar climatic condition, to the state of the ship, to the water, or to any circumstances connected with the visits of the men on shore. Pursuing the inquiry, it was ascertained that 10 of the men had used milk supplied by a native who visited the ship daily; of these 10 men 9 were affected, 4 died of cholera, and 5 had severe diarrhoea.

The native who supplied the milk kept one cow which was in good health, but he frankly admitted that the milk he supplied to the sailors contained about 25 per cent. of added water; and it also came out that several of his neighbors had suffered from cholera. A case had been imported on March 2; the dejecta from this patient drained into the tank on which the milkman's house stood. The milk was clearly the connecting link between the epidemic in the hamlet and on board the ship, and it was, without much doubt, rendered infective by the addition of the tank water fouled by the dejecta of the imported case.

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#### THE RELATION OF SUBSOIL WATER AND PREVALENCE OF CHOLERA IN THE DACCA DISTRICT.

Taking everything into consideration, it can not be said that there is any parallelism between the fluctuation of the subsoil water-level and that of cholera in this district. With a steady sinking of the subsoil water from September to March, cholera appears in October, rages with violence in November and December, and gradually becomes quiescent during the remainder of the period. It may be said that the level of the subsoil water is too deep in January, February, and March (14 to 18 feet), for its fall to have any influence, and that it was more likely to act as a cause of cholera during the time it was falling through the upper strata saturated with decomposing matter; but in April the level of the subsoil water is practically the same as in March. It fluctuates through 2 feet, 18 to 20 feet below the surface of the

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\* From Brit. Med. Jour.—New York Medical Journal, July 30, 1887.

ground, and yet cholera bursts forth with renewed violence in almost every village community, and in May, the condition of the subsoil water remaining unchanged, cholera is disappearing. It is true that in April there are frequent heavy showers of rain, which are often capable in a porous soil of moistening the upper strata, and thus favoring decomposition in them; but there is no difference between April and May in this respect. The showers are somewhat more frequent and heavy in May. In June the subsoil water is rising rapidly, but cholera almost entirely disappears. It is therefore evident to my mind that if the annual flooding during the rains and the rapid and steady fall of the level of the subsoil water during the last 3 months of the year have any influence in causing the absence of cholera in the first period, and its general prevalence during the second, there is still some other seasonal influence at work for the remainder of the year, the cholera fluctuations of which are not influenced by them.

(Dr. Crombie, civil surgeon, Dacca, abstract of his comments in *History of Cholera in India*, Bellew, London, 1885.)

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#### AN INDIAN CENSORSHIP UPON PUBLICATIONS ON CHOLERA.

NON-CONTAGIOUSNESS OF CHOLERA PROCLAIMED BY HIGH GOVERNMENT MEDICAL OFFICERS, WHILST BELIEF IN CONTAGION AND TRANSPORTABILITY IS NEARLY UNIVERSAL IN INDIA; KOCH'S CRITICISM OF CUNINGHAM AND PETTENKOFER.

Koch (*Conferenz zur Erörterung der Cholerafrage*, Zweites Jahr, 1885), concerning the differences of opinion between the highest medical officers and the great mass of medical men in India, says:

It seems that Herr von Pettenkofer has altered his views relating to the intercourse of people, especially on account of the communications of Sanitary Commissioner M. D. Cunningham, concerning the behavior of Indian cholera, but I have already shown that Cunningham's assertions must be accepted with the greatest caution. There was a time when Cunningham also was of another opinion, when he also admitted that human intercourse played a very important rôle. In the year 1867 there was a great assemblage of pilgrims at Hurdwar, and cholera was spread over the whole land to a most extraordinary extent by the returning pilgrims. Cunningham then thoroughly studied the relations between the movement of pilgrims and cholera, and came to the conclusion that cholera was in fact transported from Hurdwar in various directions by the pilgrims. Twelve years afterward, at the next great congregation of pilgrims, in 1879, he sought to prove the opposite. During this time he had completely changed his views. In 1867 he stood upon the ground of positive knowledge and his own actual observation; later he began to rely upon theoretical considerations; in his office he no longer had direct practical contact with the characteristics of cholera, and he constantly ignored the experience acquired by his own investigations, and finally came to advocate the dependence of cholera upon the influence of the monsoon, taking every opportunity to deny zealously any relation between human intercourse and cholera. We should not form an opinion of the behavior of cholera in India through the subjectively colored general history of the Sanitary Commissioner-General M. D. Cunningham, but if we wish to obtain a statement of the real facts we must consult the reports of the sanitary commissioners of the separate provinces, from which Cunningham drew his own accounts. If we examine these original reports, which do not emanate from the "Green table," but from practical life, then the matter appears in quite another light. One finds indeed among these reports, at least among those with which I am acquainted, not one in which it will not be distinctly declared that the movements of the pilgrims in India play the chief rôle in the spreading of cholera, and that the drinking water is the most important medium of infection. It is remarkable that such views conflicting with those of Cunningham remain buried in the official reports where they meet the sight of scarcely any one, and that the Anglo-Indian physicians neglect to publish in the medical press or in proper channels open to them their own personal convictions. In order to explain this singular behavior I must declare that there is scarcely an independent physician in India. They are all in the service of the state, and Cun-



ingham, who stands at the head of the Indian sanitary service, is their commander, and many instances there are to speak of the discipline which he enforces even in matters relating to science. I place before you a brochure with the title "On the Communicability of Cholera by Human Intercourse," and I believe that I am acquainted with the author, one of the upper medical officials of India. He collated out of Cuningham's general reports the passages which can be used against the well-known theory of Cuningham to show that cholera does spread through human intercourse. The author, however, does not risk the publication of his name, but gives to his book the motto "*Magna est Veritas et Prævalebit.*" In a note, the author says, without mincing words, that the way in which Cuningham makes use of his influence "in moving the government of India to suppress all expressions of opinion from the sanitary commissioners and the medical officers who differ from him," has already stirred up great bitterness among the Indian physicians. None of these physicians dare to publicly make known their divergent opinions, as an example proves which was brought up in the Daily Epidemiological Society during the time of the health exhibition in London. A military surgeon, who had expressed himself in a professional periodical against the Cuningham theory, was, without ceremony, transferred to a remote station where he could reflect at leisure upon the question if there could be another rational opinion than that of his superior. I speak of these matters here designedly in order that they may become known as widely as possible, hoping that pressure of public opinion may assist in bringing about a change in such a state of affairs.

It is of the greatest importance, not alone for medical knowledge, but above all for the safety of the human race which continues to be periodically threatened by cholera, that precisely in the land where contagious disease is most rife, in India, the most careful investigations of cholera should be prosecuted and by independent investigators uninfluenced by governmental or political influence. It is also very much to be desired that all observations made in India about cholera should become common knowledge, and that it should not be at the will of a single person to perform the part of a censor, who permits the publication only of that which accords with his possibly one-sided or quite erroneous opinions. Until now we were acquainted with the behavior of cholera in India only through Cuningham's accounts of it, and from these as well as from the communications of Herr von Pettenkofer who, as it seems to me, has based himself exclusively upon Cuningham's reports, I had obtained the opinion that in India cholera was not regarded as a communicable disease. But I was greatly astonished when I myself arrived in India and found exactly the opposite of this. Every physician with whom I came in conversation regarding cholera assured me, without being particularly questioned, that the pilgrims were the most frequent means of transporting cholera in India, and that there was not the slightest doubt that cholera is a transportable disease.

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#### CHOLERA AND THE SANITARY CONDITION IN POOREE.

In the Pooree district cholera was present in January (1887) in places far apart from each other; but as the pilgrims flocked in the disease rapidly increased and became epidemic about the end of February, first in Pooree town, and then along the pilgrim routes in Pooree, Pipili, and Khurdah circles. It also prevailed in remote places, such as Gop, Nemapara, Bolia, Patra, and Bisnapur. In ordinary years the Rathjatra (car festival), held in June or July, is by far more largely attended than the Doljatra (swing festival), held in February or March, but in 1877 the latter festival was a specially holy one, said to occur only once in a hundred years, and the crowd of pilgrims who came from all parts of India to visit Jagannath was estimated at 200,000, nearly four times as many as attend in ordinary years. In March cholera was at its height, and the mortality in the town of Pooree was very severe, the residents suffering more than the pilgrims. In April the disease ceased in the town and began to abate in the district generally, but slowly. "In former years it has been observed to abate rapidly until May, to revive in June and July, when the second festival takes place, and abate again a second time by October. This year (1877) the disease did not abate till May, but then it slowly

and steadily declined until October, a marked feature being the absence of the usual epidemic during the second festival in June and July." In November and December the usual autumnal prevalence was coincident with a minor festival held in November. Of the total 5,795 cholera deaths registered during the year, 3,905 occurred in the months of February, March, and April, and 1,230 of the number were pilgrims. The overcrowding in the town during the festival was very excessive.

The existing lodging-houses could not furnish room for more than a small fraction of these men, and thousands of pilgrims had to pass their short stay in Pooree in the open streets, gardens, under trees, etc. With an area of three square miles nearly, and a resident population of 22,695 souls, the town of Pooree was said to have received a temporary addition of nearly 200,000 souls during the months of February and March.

These unsanitary conditions of the town, which have ordinarily been great, were very materially increased during and some time after this great festival. The food supply and the water supply were extremely bad.

The rice cooked in the temple and offered to Jagannath formed the main part of the food of this immense crowd. This food is often cooked of bad and unwholesome materials, and is made available for use at extremely irregular hours, sometimes very late in the evening. It is often sold when putrid, and consequently injurious to robust health and deadly to those in low health. The irregularities were multiplied manifold at the great festival in March, 1877; hence partial starvation on the one hand, and unwholesome food on the other, no doubt predisposed the system of the pilgrims to attacks of sickness. This, combined with high religious excitement, preceded by the physical discomforts of a prolonged and wearisome journey, paved the way for any disease, especially cholera. The water supply of Pooree town has been naturally bad. The nature of the soil is porous. The human excretions were never removed, and the soil got quite saturated with ordure. During the rains these animal matters got dissolved and percolated through the soil. Wells and tanks, which form the sources of water supply in the town, could never be expected to remain uncontaminated. Besides, the tanks are used for bathing purposes, and thousands of people are seen bathing daily. Many vegetable matters, such as rice, flowers, fruits, and leaves, are largely thrown into the tanks as necessary items of religious ceremonies. These get decomposed and vitiate the tank. During the festival the water must have grown very filthy indeed. The mass of pilgrims, who had every form of physical disadvantages predisposing them to disease, drank this concentrated filth in the shape of water, and so added another potent cause of sickness to many already existing. There is no existing means of draining the city. It is said that the roads serve the purposes of surface drains, while there is absolutely no provision for subsoil drainage.

With regard to conservancy, the efforts of the health office establishment were mainly confined to street conservancy and to providing a few latrines for public use.

But they were not comprehensive, and the work of removing night-soil had just begun when the great festival and the epidemic of cholera occurred. The conservancy arrangements in private houses are bad; the private latrines consist of holes dug in the earth, and when one is filled another is opened, until all available ground is dotted with these inadequately-covered pest-holes. The accumulated ordure of years within a few feet of dwelling-houses must necessarily keep the dwellers under the influence of these obnoxious causes of ill health. This was not an exceptional state of things in the epidemic of 1877, but has, I believe, continued ever since the city became an object of religious pilgrimage. (Report by the Civil Surgeon. Abstracted from *Hist. of Cholera in India*. Bellew, London, 1885.)

The following tabulated display of the statistics of cholera epidemics in Pooree, the holy city of the worshipers at the bloody shrine of Jagannath, towards which point great pilgrimages are periodically directed from many and distant parts of Hindostan, and from whence they scatter again to their homes, show the years of recurrence of great epidemics of cholera in that town. The scattering of the pilgrims to their distant homes has frequently been coincident with outbreaks of cholera in the districts traversed on the homeward journey, and has often been thought to be the means of spreading cholera broadcast throughout India. It is for these reasons that this table finds a place here.



*Cholera admissions of the Pilgrim Hospital at Pooree in each month of the twenty-five years from 1842 to 1866.*

Years.	Jan.	Feb.	Mar.	Apr.	May	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1842.....	36	5	47	1	.....	1	7	1	.....	.....	6	6	106
1843.....	7	.....	35	.....	.....	164	25	.....	.....	.....	2	1	234
1844.....	.....	3	.....	.....	2	200	.....	.....	.....	1	.....	.....	206
1845.....	1	2	3	1	.....	2	57	2	.....	1	.....	.....	69
1846.....	2	.....	14	1	.....	72	1	.....	1	3	4	1	99
1847.....	.....	1	14	.....	1	4	29	1	.....	.....	1	.....	51
1848.....	1	5	3	3	.....	2	47	.....	.....	.....	.....	.....	61
1849.....	.....	.....	.....	.....	1	107	4	1	.....	.....	1	.....	114
1850.....	1	37	11	1	.....	.....	2	.....	.....	.....	5	1	58
1851.....	.....	.....	1	.....	2	39	28	.....	.....	.....	.....	.....	70
1852.....	.....	5	4	.....	.....	104	2	1	.....	1	3	3	123
1853.....	2	2	10	1	1	6	26	2	1	.....	.....	.....	51
1854.....	.....	6	48	.....	.....	129	18	.....	.....	1	7	1	210
1855.....	.....	2	1	.....	2	.....	156	3	.....	.....	2	1	167
1856.....	1	3	2	.....	.....	.....	.....	.....	1	2	1	.....	10
1857.....	.....	8	43	11	1	66	2	.....	.....	.....	4	.....	135
1858.....	.....	2	3	1	1	1	9	.....	.....	.....	.....	.....	17
1859.....	.....	7	8	.....	.....	.....	47	.....	.....	.....	9	.....	71
1860.....	1	8	19	1	2	96	4	.....	.....	1	.....	.....	132
1861.....	.....	.....	12	3	.....	3	27	.....	.....	4	.....	1	50
1862.....	2	5	6	.....	.....	91	20	.....	.....	1	3	.....	128
1863.....	.....	.....	1	.....	1	93	2	.....	.....	.....	.....	2	99
1864.....	1	3	.....	1	.....	1	12	1	.....	.....	4	.....	23
1865.....	.....	1	2	2	1	74	13	.....	2	.....	.....	.....	95
1866.....	1	22	26	1	.....	.....	.....	1	.....	.....	1	.....	52
Total .....	56	127	313	28	15	1,255	538	13	5	15	53	13	2,431

#### CHARACTERISTIC FEATURES OF ASIATIC CHOLERA—PRECAUTIONS AGAINST INFECTION FROM CHOLERA.\*

I. *The unequal and very partial distribution of cholera forms the first of its characteristics which I shall notice.*—Mr. Jameson in 1820 most distinctly and forcibly refers to this fact. He remarks upon the localized power of the disease as being one of its characteristic features in the northwest provinces, but as having been wanting in Lower Bengal (its endemic area); and from his time down to the present day we find epidemic cholera presenting precisely the same phenomena.

We can hardly have a better proof of this than by referring to Dr. W. Farr's map of the various places affected by the disease in England during those years in which the country has been under its influence, or by following the history of cholera in our Indian jails. Mr. Jameson informs us that the prisoners in the Alipore jail were free from the disease in 1817, although it was raging outside the walls of the prison; and even more remarkable was the case of the convicts confined in the Allahabad jail, who were daily employed in the streets of the infected city, and yet escaped the influence of the disease.

This localized action of cholera, whether occurring in countries, towns, villages, or however small the community may be, is in fact a characteristic which is more readily admitted than any of its other distinctive features, and it is a most important factor in our argument concerning its etiology, for we can hardly conceive limited outbursts of disease, such as mark the progress of epidemic cholera, to be due to any general atmospherical or (as they are commonly called) epidemic influences. This localized action must be associated in our minds with some more tangible and specific cause than an imaginary something floating about in the air, or carried by the winds from place to place.

I am convinced that if we would rigidly appreciate the circumstances of cholera we can not too strongly impress upon our mind's eye this most prominent and universally accepted feature of the disease.

\*Abstracted from Bellew on Cholera, loc. cit.

II. *The second characteristic of cholera which we may notice is hardly peculiar to this disease: the inhabitants of certain localities are especially liable to be visited by cholera, and these localities have features in common with one another, differing from other places which have usually escaped its influence.* As a general rule cholera has been most destructive in large seaport towns, and the majority of these are built on low-lying, alluvial soils, at the mouths of rivers; they are frequently densely populated.

We can hardly admit that the characteristic feature of the disease above noticed is simply due to the circumstances of the population of these towns inhabiting low alluvial soils, especially when we consider how very virulent the disease has been at times in places built on high elevations and even on lofty mountain ranges. We naturally look for some more general cause influencing the populations of all densely-peopled cities, and which would be applicable to the circumstances of the poor of all countries and nations. It seems probable that in this lies the secret of cholera committing the greatest devastation among the inhabitants of large towns—they constitute, numerically, the bulk of our population—and their habits of life, poverty, and the nature of their dwellings, render them less capable of resisting a disease like cholera, than those who live in greater affluence and under more favorable hygienic circumstances.

I have remarked, in my definition of cholera, that persons in an exhausted or bad state of health are most susceptible of the influence which engenders the disease, and it is hardly necessary for me to argue the point that the poor of our large towns are, as a general rule, in less robust health than those living in rural districts; the former become pale and anæmic, their blood is poor in red particles, and it is probable that the secretions of their stomachs and intestinal canals become impaired, inducing a state of the system, which is beyond all others, favorable to cholera. In this way, therefore, and by the fact of the accumulation of a considerable number of the inhabitants of the civilized parts of the world in large cities, we may account for the prevalence of cholera among such communities; the people are in a less perfect state of health than those living on high land, whose occupation is for the most part agricultural, leading them to pass the greater part of their lives in the pure and invigorating atmosphere of the country.

We may allow, for the sake of argument, that the food of both classes is equally nourishing; but with regard to water we can not place them by any means on an equality. In the country, the population being scanty, there is far less chance of the drinking water becoming contaminated with dejecta of persons suffering from cholera; and on high lands, accidents of this kind must be even less frequent, on account of the natural drainage of the country towards a lower level, and because much of the drinking water consumed would be drawn from small but rapid streams, having their source in pure springs among the hills. The reverse of all this is to be found in low-lying sea-port towns. The lower the level the more sluggish the surface and underground drainage, and the more likelihood, therefore, of the accumulation of contaminated water in drains and cess-pools; and the less the chance of its finding a natural outlet, the greater the probability of its percolating into wells and other sources from which drinking water is supplied. The influence of rain, again, over these low-lying localities must often be very deleterious, making cess-pools overflow, bursting drains, and in fact disseminating all the filth of our large cities into many of their almost stagnant rivers and wells, and that, occasionally, in spite of their being protected by the best of all remedies under the circumstances—a good and free supply of water delivered by properly organized water companies.

*A third characteristic of cholera I have to notice is, that no amount of over-crowding, no special condition of the soil, nor any circumstance with which we are acquainted, has ever been known to originate Asiatic cholera de novo among men removed from its endemic influence, or unless the disease has been epidemic at the time beyond the confines of India.*

For a confirmation of this distinctive feature of cholera I must appeal to the history of the disease, for in no single instance can I discover a well authenticated case which would form an exception to the above rule.



We have traced Asiatic cholera on several occasions to the Mauritius, but always after the arrival of vessels from India with persons on board who had been among those suffering from cholera. The same thing has occurred in America, Guadaloupe, the islands of the Grand Canary Group, and so on. In fact, I may with confidence challenge any one to cite an instance of epidemic cholera occurring beyond the precincts of British India, unless connected by a direct chain of cases with an outbreak of the disease in India. I do not say that it is always possible to trace cholera immediately from man to man in its progress over the world for two reasons: First, because our evidence must frequently be wanting in precise data; and, secondly, because articles of clothing or goods soiled with the dejecta of cholera patients are capable of propagating the disease.

And here let me draw the reader's attention to the facts that Australia and other large tracts of country have as yet been free from Asiatic cholera, and that these places are separated from India by extensive oceans or seas; on the other hand, that as communication with Europe has become more constant and rapid, so has epidemic cholera become more frequent in its visits to that continent, invariably pursuing the route followed by man in his passage to and from India, halting for a time in intermediate countries where the seeds of the disease have been sown to bear fruit in due season, whence fresh germs have been again transmitted to other men who have carried it a step farther towards the west. Thus has the malady been propagated from one human being to another until its influence has spread from the east as far as the western shores of America. But cholera has never appeared in America unless Europe has been first affected; it has never broken out in the west of Europe unless the eastern part of the continent has been previously under its influence; and it has never been generated in the east of Europe unless connected with an outburst of the disease in Turkey-in-Asia, Arabia, or Persia; nor have these countries been affected until the disease had previously burst out with violence over Bengal, and traveled by steady steps to the west of India.

*A fourth characteristic of epidemic cholera is, that its intensity varies during its continuance in a country or a large town, so that it has periods of little and great activity, in fact, usually well marked periods of increase, culmination, and decline.* This characteristic feature of cholera has frequently been adverted to in these pages under the terms of "outbursts" of cholera, and so on, expressing the extremely rapid way in which a community, probably previously healthy, have suddenly been smitten with cholera. Whenever the disease has appeared either in India, Europe, or America, we have had numerous instances of this kind brought to our notice. Take, for example, the advent of cholera in Paris in 1831; M. Gendrin informs us that, on the third day of the appearance of cholera in the city, he received patients into the Hotel Dieu from every quarter of Paris. The same rule holds good in instances of small communities as well as of large ones; and as a general rule the first outburst of the disease is the most malignant. We find this fact also illustrated in the case of the Paris epidemic above referred to; for, of the first ninety-eight cases admitted into the hospital, no less than ninety-six died. Instances of a similar kind are constantly presented to our notice in the history of cholera among our European regiments and native convicts in India. The disease usually declines far more gradually than it commences, and often exhibits periods of renewed activity; these, however, become fewer and less virulent in the course of time, and finally the malady disappears from the affected locality, perhaps to burst out in some neighboring town or province with a repetition of the same phenomena.

I have alluded to meteorological changes as influencing the spread of cholera over India, but we can hardly accede to this cause (well-marked as its power undoubtedly is on a large scale) any such subtle influence as that which evidently governs these local outbreaks of disease. For example, in the instance again of Paris, in 1831, we find certain villages in its neighborhood severely visited by cholera, while others absolutely escaped. We can not explain a circumstance of this kind by supposing that the atmosphere over Paris differed materially from that in these villages, and still less that the atmosphere of one village was different from that of another village within a few miles of it. No doubt facts of this description have tended to throw a mystery around this disease, which has been intensified by the terrible malignity and suddenness of its attack.

I must confess that I hardly find any of the prevailing views as to the *modus operandi* of the causes which are supposed to produce cholera in the human body to account satisfactorily for this feature of the disease. But supposing that we believe that cholera is mainly propagated by the excreta of those affected by the disease finding their way into the drinking water, and that it is only in a certain stage of decomposition that this organic matter is capable of exciting a similar action in the intestinal canal of those who swallow it, we may thus explain much which otherwise appears very mysterious in connection with cholera. The development of this idea, and the facts with which I shall attempt to raise a superstructure upon it, must remain for subsequent consideration. But I may here remark that, if we allow the possibility of the Seine having been contaminated in the manner I have suggested in 1831, and suppose that its waters became poisonous when this organic matter was in a certain stage of decomposition, and that this condition gradually declined as oxidation progressed, the water after a certain period no longer containing decomposing choleraic dejecta in a dangerous state, we may thus account for the sudden onslaught of the disease.

The intensity of this poison would be greatest probably within twenty-four hours from the introduction of the cholera stuff into the water; but this would vary with the depth of the water, the state of the atmosphere, and so on, meteorological changes influencing to a considerable extent the intensity and length of time of its decomposition, supposing, of course, the water to be once only contaminated. If the organic cholera-infecting matter found its way from time to time into the drinking water, then as each successive quantity of the nitrogenous stuff passed through a certain stage of decomposition a fresh outburst of the disease would occur among those who partook of the water at that particular period.

I maintain that this idea, if supported by fact, demands our serious consideration, for, as I have said before, we may thus account for the suddenness of the outbreak of cholera; moreover, it explains the fact that epidemic cholera has invariably sprung from a pre-existing source of disease; that it is impossible for it to break out in a locality beyond its endemic area unless the organic matter from another person suffering from cholera has been introduced into the place through the agency of man, and that as decomposition can not be set up in organic matter unless with the aid of moisture and a certain temperature, so cholera depends greatly for its diffusion upon drinking water and the range of the thermometer. Lastly, this contaminated water must be swallowed during a particular stage of the decomposition of the organic matter in order to produce any ill-effects, for as oxidation goes on the water purifies itself and in the course of a few days becomes innocuous.

I believe we must adopt some such theory as this to account for those characteristic features of cholera which we are now discussing; a freshly contaminated water explains the outburst of the disease, the oxidation of the organic matter its decline. We may in this way explain how certain villages around Paris escaped the influence of cholera, while others were terribly affected by it, supposing, in the first case, that the drinking water had escaped contamination, and in the other that choleraic matter had been introduced into it. An explanation of this kind is of course no less applicable to the case of other cities and countries than to that of Paris; in fact, if the history of cholera be read by the light of such theory as this, much which is otherwise dark and mysterious becomes comparatively easy of comprehension, and apparently discordant facts range themselves into intelligible order; and we have some weighty facts to adduce in favor of this argument, although it is necessary before handling them to endeavor to clear away much of the jungle which entangles the subject—the growth of years—of which we must be rid before we can hope to work the soil we are breaking to advantage.

*A fifth characteristic of cholera is that, after having been a certain time epidemic in a locality, it entirely disappears, unless in its endemic area.* In considering this feature of the disease we must again appeal to its history. I have already pointed out the fact that cholera is hardly endemic in any country beyond the peninsula of India, the eastern provinces of the Bay of Bengal, and Java. It has appeared over Europe and America on several occasions, but after exercising its baneful influence for a period of two or three years it has gradually died out and disappeared, until again rekindled by a fresh importation of the disease from India. Like certain tropical plants, cholera appears incapable of a long-continued existence



beyond the region from which it originally sprang ; it may, however, live and bear fruit even in the cold of a European winter if fostered in carefully-warmed conservatories, as, for instance, in the overheated houses of the Russians. Unless cared for in this way it becomes dormant in the cold of a European winter, to sprout out again in the heat of the summer, but with less vigor than in the year of its primary invasion.

As regards this feature of cholera we can not explain why the disease does not continue in vigorous growth in Europe, or, in fact, in any part of the world beyond India, but we may surely rest content with a statement of the fact. It is equally impossible to explain why certain plants and animals can only flourish in particular regions of the globe ; why, for instance, we can not keep up a vigorous European stock of human beings in India. We know this can not be, and in the present state of our knowledge must be content to receive the statement as true because experience teaches us that it is so. And so with cholera ; we know no physical laws which can account for the limitation of endemic cholera to India, nor why the disease gradually dies out after a few years of life and vigor in any other country ; but this in no way detracts from the certainty or value of the facts. This feature, moreover, does not exclusively belong to epidemic cholera, but is common to other zymotic affections, as scarlet fever, which is unknown in an epidemic form in India, or yellow fever, which can hardly exist in the north of Europe.

Facts such as these appear in a clear light when viewed in connection with others of an analogous kind with which we are more familiar. Much of my experience of cholera was gained in the district of Tirhoot, a great indigo-producing country, and every planter knows very well that if he would get good produce from his plant he can not rely on the indigenous seed ; he must import it year after year from the northwest ; if he sows seed from plant reared in the district he may have a fine crop, but he will get little or no produce out of it. He acts upon the experience he has gained and imports his seed from localities far less famed for their indigo than Tirhoot ; but this imported seed yields largely in that district. And so it is with cholera ; the imported disease is terribly prolific and fatal in its first year's growth on a new soil, and from that time it deteriorates in its power of destroying life and gradually declines.

We find this same character further illustrated in the case of new-comers into a locality under the dominion of cholera ; here the virgin soil is brought to the seed, but the same effects as in the former case have been noticed over and over again, and notably in India among the inhabitants of the Rajmahal hills. In other parts of the world facts of a similar kind have been observed, as on the arrival of recruits in the Crimea when the country was under the influence of cholera.

*A sixth characteristic feature of epidemic cholera is that every outbreak of the disease beyond the confines of British India may be traced back to Hindostan, through a continuous chain of human beings affected with the disease, or through articles stained with their dejecta.* In other words, the train of phenomena resulting in cholera beyond the confines of India must have commenced in this country ; consequently America, Europe, and the greater part of Asia may justly blame India for all they have suffered from cholera.

I have already entered somewhat at length into this subject when discussing the geographical distribution of the disease, nevertheless I must briefly touch on it again. It is to my history that I appeal in proof of the above statement ; I have there given an account of the gradual advance of the disease from Bengal over the northwest of India and into the Punjab, Cabul, and Persia, or from Bengal to Bombay, Persia, Arabia, and Turkey, in Europe, on every occasion in which the disease has appeared in Europe. Cholera has in this course invariably followed the routes by which man travels, and if it has thus spread from country to country by his agency then we may fairly assume that it has extended continuously from man to man.

It is hardly to be supposed that we can always trace the disease from A, B, and C to D, E, and F ; but if we can so follow it from A to D, and the evidence is in favor of its extending in the same way from B to E, and from C to F, it requires no great stretch of the imagination to conclude that the disease did not thus extend from man to man in the latter cases, be-

cause we are convinced it did so in the former. I have shown, for example, that out of nineteen men who drank water contaminated with cholera dejects, five were seized with cholera in less than three days. There was no chance of error in this case; the organic matter contained in the drinking water without doubt produced a disease in these people, the prominent feature of which was that the epithelium of their intestinal canals underwent a change precisely similar to that of the organic matter entering with the water, and this occurred in a community free from the disease, and living under good hygienic circumstances. Here, therefore, is the evidence of the direct communication of the disease from A to D, and from it are we not justified in concluding that under similar circumstances B and C communicated the disease to E and F, as, for example, at Hurdwar in 1867, and that they in their turn spread it over the country as described by Dr. Murray? By the evidence afforded by these cases let us thoughtfully examine the history of the disease in all times and places, and we can not but conclude that cholera is a communicable disease from man to man.

It is necessary, however, to be explicit as to the form of cholera which is thus communicable; it is *Asiatic cholera* we are discussing, and I have given the definition of the disease in the first chapter of the work. I need hardly say this differs essentially from *sporadic cholera*, which no one ever supposed to be communicable, either in this country or in any other parts of the world, and which evidently arises quite independently of any pre-existing disease, usually from overindulgence in food, or from eating unripe fruits or such like unwholesome matters. I am quite prepared to admit that there is an analogy between the diseases; I believe they are both connected with changes in the intestinal canal; but in the sporadic form there is no evidence to show that the fomes are capable of setting up a special and deadly molecular action in the intestines or otherwise healthy people, which is characteristic of *Asiatic cholera*, giving rise to the rice-water alkaline stools, and the rapid death which too frequently follows this form of disease. On the other hand it can not be denied that cholera is not easily distinguishable from sporadic diarrhoea, and I should chiefly rely upon the fact of cholera being present, and the choleric epidemic at the same time, in order to connect the two together, believing as I do that choleric is simply a modified form of *Asiatic cholera*, and is capable of engendering this more deadly form of the disease in other people by means of the dejecta.

*The seventh characteristic of cholera which I would notice is, that the more explicit the examination the clearer the fact appears that the disease, in the majority of cases, spreads from one human being to another by means of the cholera fomes finding its way into drinking water, and thus into the intestines of other people.*

If we examine all the reports with reference to the epidemic of 1865-'66, we shall notice how directly they tend to support Dr. Snow's theory, and to refute the view expressed by the *London College of Physicians* in 1854, which was to the effect that *it was never likely that water would be found to be the medium of communication in cholera*. In investigating this matter we must again return to the history of the disease, and I would especially point to the instance I have mentioned in connection with the epidemic of 1861 in the Punjab, as positive evidence of water, contaminated with cholera evacuations, being a medium of the communication of cholera from one person to many others.

Dr. Snow's Broad street case was a remarkable illustration of the influence of contaminated water in spreading the disease. Doubtless the choleraic dejecta of the first patient in this locality has passed into the well of the Broad street pump and, while undergoing oxidation, had affected many of those who partook of the water. No more definite evidence of this fact could possibly have been afforded, than when the Broad street pump-water was accidentally carried out to Hampstead, and generated the disease in two of the three persons who there partook of it.

Dr. Richardson's investigations into the spread of the disease among the men of Her Majesty's navy in the Crimea in 1854 is hardly less to the point; and Dr. W. Farr's account of the outbreak in Newcastle during the same year affords a very remarkable example of a similar kind, which, in conjunction with the explosion of cholera in the districts supplied by a certain portion of the East London water works in 1866, leaves us hardly any room to question the part played



by water contaminated by the excreta of cholera patients in the production, or rather in the extension of the disease. We may safely assume that cholera never would have been generated among those who suffered had it not been for the circumstances described in the history of these cases.

Turning now to India, we have illustrations of the same facts in the instance of the outbreak of cholera at Hurdwar in 1867. First, we have evidence of the assembling of an enormous congregation of pilgrims, some of whom had come from districts and villages in which cholera was prevalent, but the disease did not spread among them until the down-pour of rain occurred on the 11th of April, the night before the great bathing day. The assembled crowd (3,000,000 in number), having been soaked to the skin for 12 hours, rushed down in a body to the river with their wet clothes on, and drank of its water, which must thus inevitably have been contaminated with any organic matter washed off their saturated cotton garments. Within 24 hours cholera burst out in all directions among those unfortunate people, and they afterwards disseminated it throughout the country.

Nor must we omit the consideration that, if the organic matter of cholera dejecta lives, grows, and is destroyed in water, it accounts for much concerning the disease which has hitherto been a mystery. Take, for instance, the case of the ship *Britannia* in 1854. The mortality that took place on board the vessel, in which cholera broke out 16 days after leaving Varna, was very great, and yet they supplied themselves from an infected ship with additional hands and transferred some of their sick in return; but in neither case did the crew in or from the infected vessel suffer.

The *Britannia* had left an infected port. Supposing the water contained in her tanks to have been contaminated, it would have been poisonous to many of the men drinking it during a certain stage of decomposition, probably lasting from 5 to 8 days. The organic matter having then passed through this condition, might have been, and probably was drunk with impunity by those subsequently coming on board. On the other hand, the disease did not extend to the crew of the second vessel, although cholera cases were put on board, because the drinking water was preserved from contamination.

On the other hand, in the case of Calcutta, since the introduction of pure water into the town, we have seen how very materially cholera has decreased among the inhabitants of the place, demonstrating the fact that in a locality having the unenviable reputation of being the "home of Asiatic cholera," a pure supply of water has greatly diminished the death rate among its population, the mortality that still occurs from this disease among the people being attributable, in many instances, to persons who have contracted the disease beyond the precincts of the town, or who have not availed themselves of the protection afforded them by the municipal authorities—preferring river, well, or tank water to that distributed by the Calcutta water works.

I have had to record the progress of cholera on several occasions from Eastern Bengal, during one season as far to the west and northwest as Allahabad and Cawnpore, a few cases at the same time occurring in the principal cities situated on the River Jumna at Agra, Muttra, and Delhi. During the subsequent rains the whole of the northwest and Punjab have been under the influence of the disease. It seems to me that these things are best explained as follows: When the southwest monsoon sets in over Bengal the River Ganges becomes the great high road of traffic between the home of endemic cholera and the northwestern provinces. After the cold-season crops have been gathered in, and the monsoon has fairly begun to blow over Bengal, large fleets of country boats start on their journey from Calcutta, Dacca, and other emporiums of trade for Patna, Benares, Allahabad, Mirzapore, and Cawnpore, which latter place they reach about August.

The total number of country boats which passed Sahebgunge during the year 1873 were:

*Up-stream traffic.*

[Calcutta Gazette, July 9, 1873.]

Months.	Loaded boats.	Passenger boats.	Empty boats.	Total.
January .....	1,105	11	533	1,609
February .....	1,308	31	444	1,783
March .....	1,361	91	426	1,878
April .....	764	19	496	1,279
May .....	1,472	19	513	2,004
June .....	1,499	13	339	1,851
July .....	1,055	12	277	1,344
August .....	1,821	25	273	2,119
September .....	1,515	24	347	1,886
October .....	1,132	33	485	1,648
November .....	1,115	34	417	1,566
December .....	892	20	425	1,337
Total .....	15,039	332	4,993	20,364

A few of these boats sail up the Jumna as far as Agra and even Delhi. They return to the lower provinces before the Ganges subsides in September.

The southwest monsoon, therefore, would appear to be the indirect cause of the dissemination of cholera over the country, in that it brings with it moisture—a necessary element for the development of the disease, but more especially because it is before this wind that the large fleets of country boats move up the Ganges, conveying men and goods from the home of endemic cholera to be disseminated over the upper provinces. Thus the disease springs up, not only in the great cities on the Ganges at which these boats stop, but it also appears in the large towns on the Jumna. We have in these details a repetition of the old story—cholera progressing with man along the great high roads upon which he travels, spreading no faster than he moves, and being generated in wet and hot weather.

No sooner do the rains cease, and the dry west winds of the upper provinces set in—at the latter end of September or beginning of October—than cholera begins to decline over the northwest. In Bengal the rains cease later in the year, in showery weather, and a fresh outburst of the disease then occurs.

I am perfectly aware that it has been maintained by observers as far back as 1818 that the southwest monsoon has a far more direct influence in spreading the disease over the country than I am disposed to attribute to it. I can not, however, accept the notion of the monsoons being the direct means by which cholera is directly disseminated over India :

(1) Because we find that people living on the hills of Lower Bengal, and therefore under the influence of winds blowing over the endemic area of cholera, are yet free from the disease.

(2) The wind has never conveyed the disease from the coast of Burmah or India to the Andaman Islands.

(3) We have the direct testimony of independent observers that, in the great epidemic of 1818, cholera advanced down the Madras coast and across to Bombay against the prevailing monsoon. Again, in 1849, Dr. Leitch informs us that cholera advanced from the east in the teeth of the southwest monsoon, then blowing with a force equivalent to a velocity of 25 miles an hour.

(4) If the southwest monsoon carries the seeds which engender cholera in the human body from east to northwest as far as Cawnpore, why does it stop there? The disease should be disseminated over the whole country, including the northwest and Punjab, every year, if carried by the prevailing wind.

(5) It is impossible to explain the extension of cholera from Alexandria over Europe in 1865, and its steady progress from east to west over Europe and America on previous occasions, upon any theory which obliges us to accept the wind as the chief influence which causes the spread of cholera.



(6) Still less can we explain its advent in isolated localities, as the Mauritius, Fodo, and Guadeloupe, and numerous other places, if we accept the monsoon theory.

(7) Quarantine when practicable, as at Peterhoff in 1831, in Palermo in 1865, and on several occasions in Greece, has prevented the ingress of cholera into these places, which could not have been the case had the disease spread by means of the wind.

#### INCREASED MORTALITY FROM CHOLERA IN THE EUROPEAN ARMY OF BENGAL.

The following table shows that there has been a very decided increase in the mortality of European soldiers in the army of Bengal who suffer an attack of cholera. These figures seem to indicate either that the disease has essentially increased in virulence or that the therapeutics of this disease as applied in that country has retrograded rather than advanced. It is not probable that the former is the case, for there are two very cogent reasons against that assumption. In the first place the percentage of mortality among the natives attacked, where as a rule occidental systems of therapeutics are not in question (for the great majority of the native population sicken and die or recover now as formerly without the intervention of the European physician), seems to have suffered no corresponding increment. The disease among those attacked has always been, and still is, exceedingly fatal. In the second place, whilst the European epidemics which have recurred at varying intervals have grown less and less destructive with the passage of time, there seems to have been really little change in the percentage of mortality among those actually attacked. I have indeed had occasion to remark elsewhere the not very flattering fact that the only advantage experienced by the European sufferer over his East Indian brother in respect of treatment during an attack of cholera appears to be due entirely to receiving the aid of the physician at an earlier stage of the disease, the only period during which the skill of the western physician seems to be of more avail than the barbaric treatment or the fatalistic neglect accorded the immense majority of the native population of India who have the misfortune to be attacked with cholera. It would seem, therefore, rational to presume that in India the European soldier, who is attacked with cholera, does not receive sufficiently early medical attention of the most skillful character. This is all the more remarkable, since the vitality statistics of the Bengal army show that during the same period the percentage of cholera attacks to numerical strength has decidedly decreased during the same time, a result probably of improvements in hygiene and prophylaxis.

*Died out of each 100 treated for cholera, 1827-'88, in the European army of Bengal.\**

Years.	Deaths.	Years.	Deaths.	Years.	Deaths.	Years.	Deaths.
1827.....	28.13	1841.....	28.46	1855.....	50.00	1870-1879†...	70.00
1828.....	29.77	1842.....	43.46	1856.....	57.85	1880.....	71.00
1829.....	22.89	1843.....	39.77	1857.....		1881.....	72.00
1830.....	26.13	1844.....	44.81	1858.....	54.34	1882.....	55.00
1831.....	23.50	1845.....	48.67	1859.....	50.17	1883.....	66.00
1832.....	21.12	1846.....		1860.....	53.25	1884.....	63.00
1833.....	31.96	1847.....		1861.....	64.04	1885.....	64.00
1834.....	32.31	1848.....		1862.....	61.28	1886.....	69.00
1835.....	26.04	1849.....	40.74†	1863.....	75.11	1887.....	67.00
1836.....	16.17	1850.....		1864.....	69.59	1888.....	60.00
1837.....	33.42	1851.....		1865.....	72.50		
1838.....	27.70	1852.....		1866.....	60.00		
1839.....	18.50	1853.....	61.00	1867.....	60.87		
1840.....	31.25	1854.....	50.54	1868.....	65.52		

\* From Bengal, report on cholera, for 1866-'88. By Bryden.

† Eight years ending 1853. Macpherson, *Indian Annals*, 1858, p. 250.

‡ From annual report of Sanitary Commissioner with Government of India, 1890.

The following table showing the number of deaths by cholera officially reported as occurring in the city of Calcutta from 1841 to 1884, inclusive, shows great variations in the annual mortality from this disease. The apparent periodicity of rise and fall in the number of deaths from cholera in this city, I shall have occasion to refer to in a later chapter whilst discussing the very obvious periodicity of cholera epidemics in India. The table should be viewed in connection with that chapter. The last column of the table indicates a very striking fall, more or less permanent, in the number of annual deaths from this disease. This peculiarity should be considered in connection with what has already been said concerning water supply, sewerage, and conservancy in the city of Calcutta.

*Statement of deaths from cholera reported by the municipal authorities as having occurred in the town of Calcutta from 1841 to 1884.*

Years.	Deaths.	Years.	Deaths.	Years.	Deaths.
1841.....	5,177	1856.....	4,540	1871.....	790
1842.....	6,545	1857.....	3,838	1872.....	1,068
1843.....	3,739	1858.....	5,195	1873.....	1,140
1844.....	5,811	1859.....	4,676	1874.....	1,216
1845.....	6,240	1860.....	6,553	1875.....	1,668
1846.....	6,427	1861.....	.....	1876.....	1,851
1847.....	3,041	1862.....	.....	1877.....	1,418
1848.....	2,502	1863.....	.....	1878.....	1,335
1849.....	3,867	1864.....	.....	1879.....	1,186
1850.....	3,348	1865.....	5,076	1880.....	805
1851.....	4,374	1866.....	6,826	1881.....	1,893
1852.....	4,189	1867.....	2,268	1882.....	2,240
1853.....	5,632	1868.....	4,178	1883.....	2,037
1854.....	3,082	1869.....	3,592	1884.....	2,272
1855.....	3,744	1870.....	1,560		

#### CRITICISMS OF INDIAN VITAL STATISTICS BY LOCAL SANITARY OFFICIALS OF HIGH RANK.

The following abstracts from official Indian sanitary reports are quite a sufficient backing, if any were needed, of what has already been said upon this subject. In conformity with our custom, we introduce their testimony:

Now the cholera deaths shown by seasons are those occurring amongst the civil population, and the seasonal division was adopted because no reliable facts of any kind are obtainable. In speaking of the figures in our register I said on a former occasion that they are unsupported by one single fact as to antecedent conditions. They are nothing more than the bald record of so many births and deaths in such and such areas; the deaths too, reported by patels and police, whose guesses at the specified causes to which they shall be assigned are based on the garrulous and garbled statements of relatives or friends, themselves grossly ignorant. In a total population of 16,000,000 odd there are some 14,000,000 villagers, of whom the great majority live and die without ever coming under medical treatment. My impression is, that with their deaths nothing more can be done than is done. (Annual Report of Sanitary Commissioner for the Government of Bombay, 1882.)

As remarked in last year's report, no change has taken place in the mode of machinery of registering births and deaths. The returns can, therefore, only be looked upon as approximate; and until some simple legal measure is passed defining the duties of village accountants, and making the duty of reporting births and deaths to that official compulsory on every householder, they must continue to remain so. In some parts of the mofussil much opposition to registration exists, which would be amusing if it were not pernicious. Thus in Vizianagrum on a late tour the municipal manager reported to the sanitary commissioner as follows: "People much opposed to registration; think if register birth of a child it will die soon. When registrars go round receive much abuse; people cry out 'Here are these fellows wanting deaths; can't you die to oblige them,' etc. A kurnum in the Coimbatore District coolly



remarks that he "never notices births and deaths among Voddors and Pullers, who are low class inhabitants of his village." (From Annual Report of the Sanitary Commissioner for Madras, 1881.)

*CRITICISM OF CUNNINGHAM'S DEDUCTIONS FROM BALD FIGURES CONCERNING UNIVERSAL PREVALENCE OF CHOLERA AND ITS RELATIONS TO SEASONS.*

In a recent book, "Cholera: What Can the State do to Prevent it?" by Dr. Cunningham, late general sanitary commissioner and surgeon-general with the government of India, great stress is placed by the author upon the constant occurrence of scattered cases of cholera throughout the whole of India, even during the periods of quiescence and of absence of epidemics, and arguments are based upon these isolated cases with which he seeks to overthrow the doctrine of the transportability and communicability of cholera. Aside from other objections to arguments with such a basis there is the fatal objection that the Indian statistics are entirely unreliable for such purposes. While the statistics may comprise some very large figures more or less approximating the real truth, it is entirely unwarrantable to draw any deductions from them where small figures are concerned. The following abstracts from the annual reports of the sanitary commissioner of the government of India and of the sanitary commissioners for some of the Indian provinces will indicate the opinion concerning the faultiness and unreliability of the Indian mortality statistics entertained by the commissioners themselves. Further than this, it would seem to one who is acquainted with the system by which the data of the local statistics relating to the health of the native populations are originally gathered impossible that there could be even an approximation to exactness. In the first place, according to the ready admissions of nearly every Indian physician with whom one comes in contact either in Europe or in India, even for the skillful physician during his first year of experience with cholera in India there is often the greatest difficulty in distinguishing between an isolated attack of genuine cholera and an ordinary attack of cholera morbus, or nostras, following imprudences in diet on the one hand and an attack of pernicious intermittent fever on the other, the evidence furnished by autopsies being not always conclusive. And yet vital statistics of the native population are collected by the chief man of the village, who is in no way acquainted with medicine, and even his information is as a rule based upon the ignorant, and therefore inexact, statements of the families of the deceased. Of course in this case the distinction between death from pernicious malaria and common digestive disturbances is utterly impossible to be made, and reports of death as due to cholera during periods of absence of epidemics outside of the endemic area and of deaths constantly reported within the endemic area must necessarily comprise a large proportion of deaths due simply to pernicious intermittent fever as well as common cholera morbus, especially when one remembers the excessive prevalence of malarial diseases in most of these districts and the filthy habits of the populace and their habitual imprudence in eating. Even in the health reports of the military surgeons and of the civil surgeons, which concern the health of the army and of the European population in India, by standing order, emanating from the chiefs of the sanitary departments, no distinction is to be drawn between death from imprudences in diet which are likely to be by ordinary cholera morbus and those due to the genuine infectious cholera. It is incredible that deaths from both cholera morbus (cholera nostras) and pernicious malarial fever do not enter largely into the cholera statistics in India. Furthermore, the frequent practice of poisoning by arsenic is from a similarity of symptoms, likely to cause many deaths to be charged to cholera, which are really caused by poison.

From the mortality statistics published by the Spanish Government during the last four or five years it appears that there are in that kingdom 25 deaths per annum among every 10,000 of the population which are due to cholera morbus, and it is rational to infer that at least a great proportion of the recorded mortality from cholera in India should be ascribed to common cholera morbus, and to this number of deaths from inferred cholera morbus should be added even a larger number in all probability due to pernicious malaria. So that it seems in

the highest degree irrational for the recent surgeon-general of India, upon such flimsy evidence as these very imperfect statistics furnish, to base the statements so positively made, that even outside of the endemic area in India isolated cases of genuine cholera are constantly occurring. And when he undertakes to apply these hypothetical deductions from the Indian statistics to the course of cholera outside of India, and asserts with equal positiveness that there is scarcely any country in the world in which isolated cases of genuine cholera do not constantly occur, his assertion must be regarded as nothing less than absurd.

#### SEASONAL PREVALENCE OF CHOLERA.

Since some sanitarians holding high offices under the Indian Government, and a few distinguished writers in Europe and America have placed great stress upon what they term "the seasonal development of cholera," the bald statistics upon which this notion is based are reproduced here in full. It is to be hoped that these bald figures, which have been arranged so laboriously by Cunningham to show what Bryden clearly established decades before and what no one has since seriously disputed, may prove to be of some practical use when reanalyzed and rearranged by some industrious statistician who may not have access to the original sources.



## \* TABULATED STATISTICS SHOWING THE

*Districts forming the central*

No.	District.	Average population.	Jan.	Feb.	Mar.	Apr.	May.
1	24 Pergunnahs and Calcutta with its suburbs .....	2,480,363	9,441	7,778	11,148	10,291	6,627
2	Howrah .....	683,219	1,969	1,674	2,066	1,594	1,181
3	Serampore and Hooghly .....	885,131	799	861	1,421	2,058	818
4	Nuddea .....	1,915,321	5,222	3,869	10,301	13,119	5,950
5	Jessore .....	1,826,135	8,872	3,358	6,957	12,373	6,007
6	Burdwan .....	1,713,284	2,346	2,447	5,059	5,823	3,592
7	Dacca .....	1,984,672	5,691	2,068	2,786	7,813	3,263
8	Furreedpore .....	1,322,161	3,193	1,240	4,098	9,057	2,678
9	Backergunge .....	2,139,161	14,692	4,877	5,760	8,848	7,601
10	Mymensingh .....	2,700,942	3,993	2,204	1,507	3,265	3,790
11	Moorshedabad .....	1,290,208	1,403	1,727	3,656	5,495	3,131
12	Dinagepore .....	1,508,135	1,210	517	847	2,111	2,016
13	Maldah .....	693,437	701	422	1,254	3,884	2,584
14	Rajshahai .....	1,324,684	850	377	1,198	6,465	3,221
15	Rungpore .....	2,123,968	2,168	869	1,289	3,310	3,960
16	Bogra .....	711,912	456	140	356	1,502	819
17	Pubna .....	1,261,661	1,027	322	1,016	4,394	1,726
18	Purneah .....	1,781,741	228	740	4,171	12,562	5,265
19	Noakhally .....	767,353	12,460	7,317	3,084	1,957	977
20	Tipperah .....	1,526,635	3,537	2,242	2,761	3,168	1,935
	Total .....	30,640,125	80,258	45,049	70,735	119,089	67,141
	Average death-rate of each month per 10,000 of population .....		2.18	1.22	1.92	3.24	1.83
	Percentage of deaths in each month .....		12.1	6.8	10.7	17.9	10.1

*Districts situated towards the*

21	Bancoorah .....	784,262	440	767	1,163	825	1,236
22	Beerbhoon .....	745,175	800	1,445	2,859	1,962	1,651
23	Midnapore .....	2,529,382	2,478	4,321	4,849	2,962	2,181
24	Balasore .....	857,756	1,601	1,845	4,120	4,493	5,866
25	Cuttack .....	1,616,474	1,617	1,914	4,547	4,852	5,173
26	Pooree .....	829,081	856	1,711	4,551	3,380	3,570
27	Rajmahal and Deogarh .....	1,413,690	191	194	884	1,137	1,611
	Total .....	8,775,820	7,983	12,197	22,973	19,311	21,288
	Average death-rate of each month per 10,000 of population .....		.76	1.16	2.18	1.83	2.02
	Percentage of deaths in each month .....		4.6	7	13.1	11.1	12.2

\* Copied from Sanitary Commissioner Cuningham's book: "Cholera: What can the State do to prevent it?"

## SEASONAL PREVALENCE OF CHOLERA IN INDIA.\*

*portion of the endemic area.*

June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total deaths.	Average annual death rate per 10,000 of population.	Maximum No. of deaths in any one of the 12 years.	Minimum No. of deaths in any one of the 12 years.	No. of years death-rate exceeded 1 per 10,000.	No.
3,205	1,447	1,377	1,463	2,298	6,351	13,628	75,054	25.22	10,934	794	12	1
709	405	370	596	790	1,439	2,825	15,618	19.05	1,893	393	12	2
399	298	358	406	501	883	1,538	10,340	9.74	1,473	454	12	3
997	439	162	291	1,287	7,668	9,877	59,182	25.75	11,020	528	12	4
1,682	702	265	205	2,097	9,902	16,737	69,247	31.60	14,822	1,906	12	5
2,323	1,247	880	524	468	680	2,189	27,578	13.41	5,276	144	11	6
867	398	745	858	2,095	9,251	13,734	49,569	20.81	11,257	427	12	7
475	190	338	301	2,612	7,386	8,309	39,877	25.13	14,135	303	12	8
2,152	694	312	203	736	2,328	14,238	62,441	24.32	19,177	291	12	9
1,860	619	393	449	1,963	6,636	9,214	35,893	11.07	7,979	250	12	10
1,232	391	213	276	897	2,490	2,652	23,563	15.22	4,163	539	12	11
801	680	241	207	145	572	1,605	10,952	6.05	2,306	214	12	12
561	288	177	69	416	1,626	1,752	13,734	16.50	4,401	52	11	13
493	106	96	118	1,156	2,649	2,887	19,616	12.34	3,330	161	12	14
1,884	1,265	886	435	1,078	2,802	4,735	24,681	9.68	5,664	49	11	15
226	189	67	296	1,083	2,851	1,498	9,483	11.10	1,888	104	12	16
301	91	53	230	2,366	6,403	4,807	22,736	15.02	3,937	312	12	17
1,009	459	341	429	755	1,701	963	28,623	13.39	8,870	117	10	18
267	108	190	95	139	5,685	13,312	45,591	49.51	21,858	75	11	19
534	177	104	52	242	1,936	4,331	21,019	11.47	3,488	359	12	20
21,977	10,193	7,568	7,593	23,124	81,239	130,831	664,797	.....	.....	.....	.....	.....
.59	.28	.21	.21	.63	2.21	3.56	18.08	.....	.....	.....	.....	.....
3.3	1.5	1.1	1.1	3.5	12.2	19.7	100	.....	.....	.....	.....	.....

*margin of the endemic area.*

1,158	968	580	224	96	208	497	8,162	8.67	1,954	38	11	21
1,580	672	690	250	146	400	954	13,409	15.00	3,996	80	12	22
2,852	2,731	1,014	474	560	1,190	2,476	28,088	9.25	5,627	68	11	23
6,944	5,195	1,041	457	740	1,612	2,388	36,302	35.27	7,361	49	11	24
5,918	6,225	3,101	2,510	2,513	3,494	3,506	45,370	23.39	7,296	124	11	25
5,119	5,525	2,103	891	710	1,965	2,430	32,512	32.68	7,569	9	11	26
1,751	1,998	1,315	697	370	578	194	10,920	6.44	2,096	114	10	27
25,322	23,315	9,844	5,503	5,135	9,447	12,445	174,763	.....	.....	.....	.....	.....
2.41	2.21	.94	.52	.49	.90	1.18	16.6	.....	.....	.....	.....	.....
14.5	13.3	5.6	3.2	2.9	5.4	7.1	100	.....	.....	.....	.....	.....



*Districts of Bengal and the northwest province*

No.	District.	Average population.	Jan.	Feb.	Mar.	Apr.	May.
28	Manbhoom .....	1,026,899	48	205	433	750	2,141
29	Hazaribagh .....	938,308	2	30	213	312	356
30	Ranchee .....	1,423,184	18	23	66	184	617
31	Chybassa .....	488,493	32	75	196	173	113
32	Monghyr .....	1,891,380	16	24	453	3,044	6,991
33	Bhaugulpur .....	1,896,224	32	106	2,579	8,185	5,119
34	Gya .....	2,037,216	28	38	326	1,684	4,383
35	Patna .....	1,658,080	53	33	508	2,729	4,432
36	Shahabad .....	1,844,441	129	110	169	1,254	4,781
37	Sarun .....	2,172,121	24	45	49	466	1,698
38	Tirhoot and Darhhanga .....	4,800,107	71	65	269	4,540	15,545
39	Chumparun .....	1,581,211	24	3	113	1,758	2,840
40	Ghazipur and Ballia* .....	1,635,633	32	90	154	1,184	2,919
41	Benares* .....	842,980	301	365	1,073	2,649	2,000
42	Mirzapur* .....	1,095,605	81	85	771	2,733	3,004
43	Azamgarh* .....	1,495,263	37	65	421	3,393	3,566
Total .....		26,827,145	928	1,362	7,793	35,038	60,505
Average death-rate of each month per 10,000 of population .....			.03	.04	.24	1.09	1.88
Percentage of deaths in each month .....			.3	.4	2.1	9.7	16.7

\* In the northwestern provinces.

*Eastern districts of the northwestern provinces and Oudh (exclud-*

44	Jaunpur .....	1,112,545	115	134	1,716	8,803	2,210
45	Gorakhpur .....	2,300,468	19	48	745	10,764	6,449
46	Basti .....	1,543,154	31	41	2,464	15,730	10,738
47	Allahabad .....	1,433,645	301	203	701	3,305	3,271
48	Futtehpur .....	682,265	33	53	27	93	631
49	Partabgarh .....	891,550	194	221	1,635	5,153	2,158
50	Rai Bareilly .....	867,389	147	44	142	525	4,367
51	Sultanpur .....	943,967	414	447	2,088	7,650	3,007
52	Fyzabad .....	1,259,214	102	195	1,242	6,204	3,815
53	Unao .....	812,009	2	6	13	820	1,196
54	Barabanki .....	651,082	35	56	269	2,340	2,072
55	Gonda .....	1,219,371	36	59	1,048	6,820	7,751
56	Bahraich .....	826,243	1	13	176	3,884	2,696
57	Kumaon .....	439,715	89	249	311	1,955	3,784
58	Dehra .....	123,451		1		230	668
59	Garhwal .....	327,788	10	2	3	597	1,720
Total .....		15,733,856	1,523	1,772	12,690	74,773	56,533
Average death-rate of each month per 10,000 of population .....			.09	.09	.67	3.96	2.99
Percentage of deaths in each month .....			.6	.7	4.7	27.7	20.9

*situated between the endemic and epidemic areas.*

June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total deaths.	Average annual death rate per 10,000 of population.	Maximum No. of deaths in any one of the 12 years.	Minimum No. of deaths in any one of the 12 years.	No. of years death-rate exceeded 1 per 10,000.	No.
3,249	2,198	867	145	90	52	64	10,242	8.31	2,936	51	10	28
907	1,856	1,962	831	270	41	3	6,783	6.02	2,444	61	11	29
1,707	3,633	4,545	1,420	173	51	37	2,474	7.30	5,566	28	6	30
821	808	258	82	46	48	39	2,691	4.59	1,476	5	9	31
7,699	3,920	2,175	742	734	494	349	26,641	11.74	6,999	177	11	32
2,922	3,530	3,216	1,618	1,242	711	221	29,481	12.96	7,719	196	12	33
8,177	10,914	6,595	2,297	870	321	119	35,752	14.62	10,107	285	12	34
5,993	6,910	4,059	816	381	260	168	26,342	13.24	5,078	285	12	35
6,319	6,482	4,915	1,529	881	227	184	26,980	12.19	6,619	62	11	36
3,356	4,274	5,154	2,478	689	239	107	18,579	7.13	3,534	222	12	37
21,313	13,915	10,561	4,004	1,517	470	113	72,383	12.57	23,025	85	11	38
3,965	4,505	9,341	4,939	812	102	.....	28,402	14.97	5,362	30	11	39
3,721	3,911	2,875	1,179	500	140	83	16,788	8.55	5,647	126	11	40
1,818	1,774	1,493	695	420	161	154	12,903	12.76	2,125	251	12	41
3,786	2,719	1,442	665	176	52	29	15,543	11.82	3,612	109	12	42
3,349	3,247	3,018	1,613	1,098	207	45	20,049	11.17	3,673	224	12	43
79,102	74,586	62,476	25,053	9,899	3,576	1,715	362,033	.....	.....	.....	.....	.....
2.46	2.32	1.94	.78	.31	.11	.05	11.25	.....	.....	.....	.....	.....
21.8	20.6	17.3	6.9	2.7	.10	.5	100	.....	.....	.....	.....	.....

*ing the districts of the northwestern provinces contained in No. III).*

1,079	610	555	440	263	73	25	16,023	12.01	8,251	15	10	44
4,541	2,713	2,132	2,686	3,714	945	160	34,916	12.65	3,314	16	11	45
7,011	2,384	624	187	850	1,112	677	41,849	22.60	9,537	49	10	46
2,650	960	761	322	198	87	24	12,683	7.37	3,615	15	11	47
1,452	700	630	316	179	22	6	4,142	5.06	917	4	8	48
1,086	667	253	2	1,786	1,287	356	15,448	14.44	6,129	.....	10	49
6,300	2,325	1,699	502	1,324	1,420	861	19,656	18.88	6,635	4	9	50
2,402	1,195	534	257	1,264	3,365	2,962	25,585	22.59	5,704	2	9	51
1,716	1,152	628	205	562	1,529	689	18,139	12.00	3,135	25	11	52
1,785	1,023	1,067	467	230	52	203	6,864	7.04	1,926	2	9	53
1,567	1,342	1,819	1,047	2,015	2,004	602	15,168	13.29	4,612	8	9	54
5,677	2,823	1,434	1,169	985	387	162	28,351	19.38	6,122	.....	10	55
2,309	1,445	1,745	1,199	1,018	293	67	14,846	14.97	3,376	1	9	56
2,805	596	154	36	43	111	221	10,354	19.62	6,894	1	6	57
105	64	175	11	9	.....	.....	1,263	8.53	636	.....	3	58
1,436	852	104	18	.....	6	15	4,763	12.11	3,473	.....	3	59
43,921	20,851	14,314	9,514	14,440	12,693	7,030	270,050	.....	.....	.....	.....	.....
2.33	1.11	.76	.50	.76	.67	.37	14.30	.....	.....	.....	.....	.....
16.3	7.7	5.3	3.5	5.3	4.7	2.6	100	.....	.....	.....	.....	.....



*Western districts of the northwest provinces*

No.	District.	Average population.	Jan.	Feb.	Mar.	Apr.	May.
60	Cawnpore .....	1,185,129	20	15	26	263	897
61	Lucknow .....	833,725	20	13	80	692	859
62	Hardoi .....	959,303	21	2	14	166	266
63	Sitapur .....	944,238	47	61	415	1,760	1,684
64	Kheri .....	784,827	.....	7	62	1,013	1,184
65	Fatehgarh .....	911,776	14	9	20	38	235
66	Jalaun .....	411,707	2	9	5	11	19
67	Etawah .....	674,407	5	3	8	30	29
68	Jhansi .....	322,500	.....	.....	.....	2	1
69	Lalitpur .....	248,617	.....	.....	11	14	26
70	Mainpuri .....	750,718	2	1	1	10	69
71	Etah .....	685,437	9	7	12	22	107
72	Shahjehanpur .....	887,898	7	11	16	26	67
73	Budaon .....	898,131	17	23	46	65	114
74	Bareilly and Philipbheet .....	1,473,368	27	19	32	141	310
75	Moradabad .....	1,125,239	26	47	56	173	124
76	Aligarh .....	973,363	22	6	37	93	378
77	Bulandshahr .....	862,651	11	6	27	57	264
78	Meerut .....	1,256,365	5	15	23	136	269
79	Bijnor .....	706,213	21	21	41	482	238
80	Muzaffernagar .....	720,316	11	17	24	211	134
81	Saharanpur .....	923,014	26	15	41	644	235
82	Terai Pergunnahs .....	171,550	.....	25	56	249	139
Total .....		18,710,492	313	332	1,053	6,298	7,648
Average death-rate of each month per 10,000 of population .....		.....	.01	.01	.05	.28	.34
Percentage of deaths in each month .....		.....	.2	.2	.7	4.2	5.2

*Districts of Agra, Muttra, and the*

83	Agra .....	1,001,600	7	14	37	239	322
84	Muttra .....	736,006	15	13	68	322	260
85	Gurgaon .....	666,185	1	1	6	97	396
86	Delhi .....	626,182	4	2	1	81	216
87	Rohtak .....	545,284	3	3	3	333	1,485
88	Hissar .....	494,432	2	.....	1	394	2,302
89	Sirsa .....	232,035	.....	.....	.....	175	680
90	Ferozepore .....	591,967	.....	.....	1	4	395
91	Karnal .....	616,774	.....	2	4	14	1,552
92	Umballa .....	1,038,108	6	7	8	234	733
Total .....		6,548,573	38	42	129	2,693	8,341
Average death-rate of each month per 10,000 of population .....		.....	.....	.01	.02	.34	1.06
Percentage of deaths in each month .....		.....	.1	.2	.5	11	34.1

*Districts forming the eastern*

122	Sumbulpur .....	319,894	18	193	486	303	129
123	Bilaspur .....	612,093	.....	88	341	1,090	4,143
124	Raipur .....	991,752	76	117	322	2,496	9,008
125	Balaghat .....	310,328	7	23	12	169	1,042
126	Jubbulpore .....	431,063	35	86	43	314	973
127	Hoshangabad .....	444,109	34	15	100	494	1,069
128	Marwara .....	211,849	18	36	29	180	338
129	Seoni .....	378,192	7	75	50	66	711
Total .....		3,699,280	195	633	1,383	5,112	17,413
Average death-rate of each month per 10,000 of population .....		.....	.04	.14	.31	1.15	3.92
Percentage of deaths in each month .....		.....	.2	.9	1.9	7.0	23.7

and Oudh (excluding Agra and Muttra).

June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total deaths.	Average annual death rate per 10,000 of population.	Maximum No. of deaths in any one of the 12 years.	Minimum No. of deaths in any one of the 12 years.	No. of years. death-rate exceeded 1 per 10,000.	No.
1,261	877	1,528	1,381	934	83	7	7,292	5.13	1,609	23	9	60
1,372	1,268	2,082	795	519	743	439	8,882	8.88	1,795	6	11	61
1,396	2,302	5,109	2,090	1,609	218	26	13,219	11.48	5,997	1	4	62
1,121	2,035	5,091	3,105	1,864	596	96	17,875	15.78	9,180	10	7	63
388	596	2,508	2,478	3,504	1,694	171	13,605	14.45	4,681	1	9	64
411	716	1,859	1,402	723	31	14	5,472	5.00	2,538	2	3	65
87	236	399	577	109			1,454	2.94	499	2	7	66
606	761	844	522	150	6	3	2,967	3.67	1,450	1	4	67
13	66	510	222	12			826	2.13	353		3	68
137	261	46	35	148	8		686	2.30	502		2	69
566	877	619	734	116	24	2	3,021	3.35	1,771		4	70
222	413	671	825	389	49	5	2,731	3.32	1,861	6	4	71
69	423	6,074	3,736	4,844	905	170	16,348	15.34	5,738	2	7	72
65	262	772	2,735	3,183	274	61	7,617	7.07	3,552	22	9	73
237	353	3,784	6,608	6,362	809	76	18,758	10.61	10,393	10	7	74
101	147	1,256	2,176	1,394	79	17	5,596	4.14	1,131	18	9	75
1,025	754	1,339	1,246	179	39	22	5,140	4.40	2,372	18	5	76
465	195	1,310	1,941	191	9	9	4,485	4.33	2,381	4	5	77
359	227	596	1,323	81	13	6	3,053	2.02	1,574	3	4	78
61	38	46	672	1,057	176	32	2,885	3.40	1,300	7	6	79
92	700	204	347	51	2	6	1,169	1.35	561	1	4	80
174	73	868	812	145	22	30	3,085	2.79	1,351	1	4	81
76	8	314	796	532	237	26	2,458	11.94	669		9	82
10,304	12,958	37,829	36,558	28,096	6,017	1,218	148,624					
.46	.58	1.69	1.63	1.25	.27	.05	6.62					
6.9	8.7	25.5	24.6	18.9	4.1	.8	100					

eastern portion of the Punjab.

603	648	691	768	297	48	12	3,686	3.07	869	13	6	83
684	414	332	372	197	135	20	2,832	3.21	733	5	7	84
371	209	326	272	25	28	2	1,734	2.17	753		5	85
427	140	128	158	18	29	27	1,231	1.64	416		4	86
302	144	7	1	3	9	2	2,295	3.51	2,020		2	87
414	45	56	17	67	1		3,899	6.57	3,674		3	88
249	86	31	3	1	1		1,226	4.40	1,088		3	89
1,274	292	138	147	43	5		2,299	3.24	1,947		2	90
713	101	187	142	3	3		2,921	3.95	1,606		4	91
560	156	284	318	55	3	3	2,367	1.90	1,121	1	4	92
5,597	2,235	2,180	2,198	709	262	66	24,490					
.71	.29	.28	.28	.08	.04	.01	3.12					
22.8	9.1	8.9	3 "	2.9	1.1	.3	100					

portion of the central provinces.

958	632	419	357	153	23	27	3,698	9.63	1,581		9	122
4,322	3,804	4,925	317	18	38	41	16,127	21.96	8,040		6	123
8,931	7,228	3,487	855	337	239	3,132	36,228	30.44	17,076		8	124
684	442	494	151	11	42	20	3,097	8.32	1,695		6	125
1,109	854	683	282	54	39		4,472	8.65	1,697		5	126
1,256	635	345	207	111	19	12	4,297	8.06	2,371		5	127
256	187	166	112				1,322	5.20	722		5	128
1,061	308	1,005	256	57	115	12	4,223	9.31	1,976		5	129
18,577	14,590	8,524	2,537	741	515	3,244	73,464					
4.19	3.29	1.92	.57	.17	.12	.73	16.55					
25.3	19.9	11.6	3.4	1.0	.7	4.4	100					



*Districts of the*

No.	District.	Average population.	Jan.	Feb.	Mar.	Apr.	May.
165	Ganjam .....	969,084	672	813	2,585	3,046	3,316
166	Vizagapatam.....	1,325,105	613	966	1,803	1,007	947
167	Godavery .....	1,509,783	1,566	439	223	304	2, 80
168	Kistna .....	1,449,659	3,677	3,354	2,133	838	1,150
169	Nellore .....	1,231,132	10,038	5,430	1,807	778	493
170	Madras .....	389,739	1,964	1,493	853	610	1,158
171	Chingleput .....	859,906	2,067	766	412	384	731
172	South Arcot .....	1,755,570	5,262	3,971	2,928	2,173	3,392
173	Trichinopoly.....	1,102,991	4,874	1,911	1,442	1,530	2,507
174	Tanjore .....	1,845,044	11,306	5,281	1,802	939	3,315
175	Madura .....	1,238,581	3,004	1,696	1,461	1,273	2,710
176	Tinnevely .....	1,608,824	5,729	2,534	2,793	2,327	1,207
177	Kurnool .....	842,545	2,051	1,550	2,324	2,703	2,485
178	Cuddapah .....	1,247,863	10,192	8,430	3,781	2,852	3,603
179	Bellary .....	1,666,911	4,341	7,652	8,569	5,985	5,856
180	North Arcot.....	2,014,766	13,250	11,032	7,551	4,205	4,840
181	Salem .....	1,966,679	9,686	9,549	10,280	9,846	9,129
182	Coimbatore .....	1,762,976	4,099	4,712	3,439	4,154	6,489
183	Neilgherries .....	60,949	.....	28	42	132	214
184	South Kanara .....	918,202	432	272	203	332	176
185	Malabar .....	2,244,739	2,711	2,300	2,406	2,631	2,604
	Total .....	28,010,448	.....	.....	.....	.....	.....

*Districts of Assam.*

201	Lakhimpur .....	150,580	48	46	81	263	737
202	Sibsagar.....	333,432	1,066	815	1,485	1,824	1,170
203	Nowgong .....	283,484	355	173	479	1,520	2,434
204	Darrang .....	254,670	166	263	1,084	2,394	3,087
205	Goalpara .....	445,496	421	250	268	815	1,513
206	Cachar.....	247,226	235	342	488	734	824
207	Syhet .....	1,844,274	2,534	1,567	2,067	3,525	3,425
208	Kamrup .....	603,321	2,189	2,072	1,335	2,337	5,544
	Total.....	4,162,483	.....	.....	.....	.....	.....

*Madras Presidency.*

June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total deaths.	Average annual death rate per 10,000 of population.	Maximum No. of deaths in any one of the 12 years.	Minimum No. of deaths in any one of the 12 years.	No. of years death-rate exceeded 1 per 10,000.	No.
3,436	3,079	1,405	565	299	1,196	1,077	21,489	18.48	8,384	73	9	165
2,345	3,768	2,529	1,614	1,124	1,215	937	18,868	11.87	6,923	.....	6	166
4,416	9,640	6,827	3,310	2,075	1,870	1,420	34,270	18.92	9,548	.....	6	167
2,325	4,226	4,967	3,626	941	551	1,395	29,183	16.78	12,374	.....	6	168
549	973	2,942	3,053	1,141	1,352	4,357	32,913	22.28	19,476	.....	6	169
625	711	853	611	320	401	714	10,313	22.05	6,246	.....	7	170
554	1,128	1,019	560	466	442	591	9,120	8.84	4,391	.....	5	171
3,015	7,826	8,271	4,569	1,831	2,033	3,239	48,510	23.03	25,783	8	7	172
2,458	5,047	4,425	2,938	1,238	1,500	3,640	33,500	25.31	15,447	.....	8	173
8,004	10,939	4,335	2,668	1,483	941	4,649	55,662	25.14	18,125	23	8	174
1,830	1,679	2,973	2,979	3,939	5,278	5,265	34,087	22.93	15,647	.....	7	175
1,277	1,455	2,623	3,346	2,187	2,219	6,539	34,236	17.73	14,214	.....	7	176
1,846	2,083	1,627	947	394	1,068	1,061	25,139	24.86	11,758	.....	5	177
3,970	5,226	5,303	3,586	1,212	1,335	4,062	53,552	35.76	33,102	.....	5	178
6,590	4,869	2,681	1,219	1,022	1,701	3,126	53,611	26.80	30,183	.....	4	179
3,069	5,172	5,699	4,107	2,649	1,693	4,528	67,795	28.04	42,145	.....	7	180
3,585	2,790	3,083	4,014	2,510	3,161	6,144	73,777	31.26	47,633	.....	8	181
4,420	3,281	3,549	5,620	4,798	6,019	6,578	57,158	27.02	36,622	.....	7	182
69	11	14	11	8	.....	9	538	7.36	476	.....	5	183
338	367	370	388	537	714	712	4,841	4.59	2,900	.....	6	184
3,451	3,152	2,786	1,293	959	1,387	1,865	27,545	10.23	11,303	5	6	185
.....	.....	.....	.....	.....	.....	.....	726,107	.....	.....	.....	.....	.....

*Districts of Assam.*

801	600	180	126	44	201	76	3,203	19.34	855	22	11	201
876	641	335	276	803	2,334	2,563	14,188	35.46	3,919	337	12	202
3,594	2,454	773	641	1,049	1,488	1,222	16,182	47.57	3,106	168	12	203
2,868	1,788	699	236	329	352	561	13,827	45.24	4,148	59	12	204
975	903	420	279	812	922	1,070	8,648	16.18	2,288	57	12	205
456	135	59	84	99	274	417	4,147	13.98	1,342	5	11	206
1,324	438	350	476	1,514	2,974	4,188	24,382	11.02	7,393	39	11	207
6,359	4,515	2,515	1,530	1,062	1,084	1,711	31,253	43.17	7,896	320	12	208
.....	.....	.....	.....	.....	.....	.....	115,830	.....	.....	.....	.....	.....



GENERAL REMARKS UPON THE DEMOGRAPHY OF INDIA IN RELATION TO CHOLERA IN THAT COUNTRY.

After the perusal of what has been noted concerning the hygienic surroundings and the manners and customs of the inhabitants of India, I think it will not be difficult for the reader to conceive how readily any infectious or contagious disease whatever, that is conveyable by the drinking water or by milk which is adulterated with it, will find the best means universally at hand for its wide dissemination throughout that country. Especially is this the case with such a disease as Asiatic cholera. With few exceptions the drinking water of the large towns in India is subject to all sorts of contaminations, and in the villages the character of the drinking water is in reality diluted sewage. There are many things remarkable about the Hindoos. One of the most striking is the fanatical reverence for their sacred writings and their religious traditions, upon which in the main their rigorous systems of caste are based. Indeed, nearly every movement or ordinary incident or act in the daily life of this curious people is prompted or regulated by caste requirements and reverence for the teachings of their sacred writings as interpreted by the priestly caste and by the inflexible customs of centuries. The language of the shastras has been quoted to show that their sacred laws enjoin the preservation of water from every kind of pollution. Yet, what has been recited indicates how these commands are constantly and universally set at naught in the ordinary daily life of priest and pariah alike. It is impossible to imagine how drinking water can be worse polluted than that which fills the Indian *tank*, whether the latter be sacred or vulgar. As a rule it serves as a receptacle, both direct and indirect, of human ordure and nearly every other abomination, yet so long as its commonly stagnant water be not "polluted" by the touch or the shadow of the "vile pariah," it is swallowed and bathed in habitually—if the tank be sacred this is often done even with a sentiment of holy unction. Let cholera appear around one of these *tanks* and it is easy to understand how, with the clothing of the sick washed in its water, and the abdominal discharges finding their way into the water, the disease can rapidly become epidemic among the native inhabitants of the neighborhood. Imagine that whilst a band of pilgrims is passing through a district to or from their sacred shrine it is suffering with cholera. In their route they stop from time to time to "bathe" in these tanks. Is it necessary in such a case to report to the *hypothesis* that the monsoon has "blown" the cholera to the dwellers around such tanks or that the season has been favorable for the "generation" of an epidemic among them; or endeavor to impose upon the credulity of man by fatuously denying that the disease can not have been "transported" by the suffering pilgrims and scattered by them among the inhabitants of the districts through which they have marched, for the reason that "cholera is essentially but a form of pernicious malaria?" There is the strongest evidence to show that such cholera-stricken bands of Hindoo pilgrims constitute one of the most frequent means of carrying and spreading cholera throughout India.

Fortunate it would be for the outside world if the Hindoos were the only East Indian inhabitants who are addicted to pilgrimages. But the population of India is one-third Mohammedan, and these people often carry with them on their way to Mecca, or to their holy cities in Persia, the seeds of the disease which the population of their native districts in India, or of those through which they pass, have already received directly or indirectly from Bengal.

It is at the port of Bombay that the immense majority of the East Indian Mohammedan pilgrims to Mecca and to shrines upon the Tigris and Euphrates embark. It is also from this port of embarkation that the annual reports of the sanitary commissioner for the presidency of Bombay are issued, in one of which we find the astonishing declaration that cholera is only a pernicious form of malaria, and is therefore no more transportable or contagious than is the latter purely local disease.

What has been said concerning the movements of cholera in the East anterior to the outbreak of the Egyptian epidemic of 1883, at Damietta, shows that the epidemic in 1881, 1882 and 1883, of the disease at Mecca were each time caused by the arrival in that city of pilgrims

who had cholera among them and who had previously embarked at Bombay where cholera was at the time prevalent. It will be remembered also that it is believed the epidemic at Brindisi of 1886, originated by direct importation from Bombay. Again, the epidemics of cholera in the Asiatic provinces of the empire of Turkey, of the last two years, which so seriously threatened an invasion of southern Russia, proceeded from Mohammedan cholera-stricken pilgrims who entered the dominion of the Sultan by way of the Persian gulf, and who embarked at Bombay. At the present time (1890) cholera is again raging in the empire of Japan, and Europe is again in great danger of a visitation of cholera by reason of a severe epidemic at Mecca, caused, as usual, by importation of the seeds of the disease with East Indian pilgrims, whose point of embarkation was Bombay. Thus Europe, and through her, also the western hemisphere has been annually, for the last nine years, jeopardized by East Indian pilgrims who have sailed from the port of Bombay. Bengal is universally acknowledged to be the natural and constant home of cholera. But, since the Red Sea has become the almost exclusive highway of trade between the far East and the West, it is nearly always that the westward march of the disease beyond the confines of India has begun in the port of Bombay. With this history of the origin of the western migrations of cholera before us, it is pertinent to ask what, besides the declaration of the highest sanitary official of the Presidency of Bombay that "cholera is only a form of malaria and therefore not transportable" and assurances of a similar character from high sanitary officials representing the Government of India and of Great Britain in International Health Congresses, has been done at Bombay to safeguard the enormous interests of the whole world against the danger of repeated visitations of Asiatic cholera having that origin? In my opinion absolutely nothing that we have any reason to hope will prove effectual. The sole measure undertaken by the Government of India looking to the arrest of the march of cholera from Bombay westward is the recent establishment and more or less perfunctory enforcement of a quarantine on the island of Camarán on the south side of the Arabian Gulf, where East Indian steamers having cholera among the pilgrims from Bombay to Mecca are stopped for a short period. So long as there is no proper and disinterested sanitary inspection at Bombay of the hordes of Mohammedan pilgrims who embark at that port, and so long as the practice of systematic concealment of cholera by the ship's officers on board steamers conveying pilgrims is not vigorously suppressed we have no reasonable ground to expect that this great route of trade between Europe and the East will cease to be also the chief route by which cholera periodically invades Europe and through her, also the western hemisphere. The rest of the world have the right to demand that they shall not be repeatedly subjected to the loss of billions of treasure and millions of human lives in order that a few ship masters and ship owners may gain a few "lacs" of rupees by the transportation annually of some thousands of fanatics who frequently have cholera among them.

Inasmuch as it seems to be the present policy of the Government of India and of the Home Government of Great Britain, as indicated by the course pursued by their chief sanitary and diplomatic officers, to induce other States to abandon quarantine as a means of protection against invasions of cholera and rely in the main upon hygienic improvements for the suppression of this disease, it appears to me pertinent also to inquire what is being done in India which affords any reasonable hope that the outside world will soon cease to suffer enormous damage by an epidemic disease which periodically spreads from its constant home in Bengal, throughout Hindostan and at all too short intervals escapes beyond the confines of India?

We have already seen how universally filthy surroundings accompany ravaging outbreaks of cholera all over the world, and it can be readily understood why it is next to impossible to control perfectly an outbreak of this disease where such favorable conditions exist for the development of an epidemic of cholera after the implantation of the seeds of the disease. Now, what progress have the East Indian Government made in such sanitary improvements as common experience has again and again demonstrated to be effectual in arresting the spread of cholera? The vast majority of the inhabitants of India dwell in villages. What is the improvement in the sanitary condition of these filthy villages since the Government of India may be presumed to have been earnestly engaged in the work of extinguishing cholera in that



country by sanitation? As to the matter of *conservancy*, let one of the high sanitary officials testify. It is stated in the Annual Report of the Sanitary Commissioner for the Presidency of Madras, 1881, that of 47,242 villages examined as to the hygienic condition there was provision for the removal of filth in only 639, and that even in this small number of villages the provision for conservancy existed only in the neighborhood of the divisional headquarters. That Madras is in a worse sanitary condition than other provinces in Hindostan no one familiar with the habits of the people of India will for a moment admit. Concerning the hygienic surroundings of the native population of Calcutta, what has been stated in the official report of Dr. Simpson, the health officer of that city, shows the miserable sanitary condition of even the great city which has long been the seat of the General Government of India. This report shows the state of that city after decades of presumed energetic efforts to improve the sanitary condition of the population. According to that official report it would seem that there has actually been many times a retrograde movement rather than a regular progress in sanitary improvements. Of the truth of some of the statements of this energetic and accomplished sanitarian I can bear personal witness. Yet for the honest manner in which he has exposed in his official report the truly filthy sanitary condition of the native population of the city of Calcutta and the urgent necessity for prompt and radical reforms he has received an official public reprimand, in which the varnished reports of his official predecessors were quoted in contradiction of his fearless statements. Bad as the condition of Calcutta is as regards cleanliness, it is safe to say that it is no whit worse than that of any other city in Hindostan, and is far better than that of many. With respect to improvement in water supply, there has been even less progress than in the matter of conservancy. Not more than a dozen cities in India have been given a fairly pure water supply. As to the great mass of the population of India who dwell in villages absolutely nothing worthy of mention has been done towards supplying pure drinking water.

The cleansing of India to such a degree that good hygiene could be safely trusted to stop the progress of cholera in that country is a truly Herculean task. It could not be completed in fifty years, even if the whole revenue of the Government of India, great as it is, were year by year expended exclusively for the accomplishment of that end. The efforts now made and the money now spent in that direction, it may be emphatically said, can never accomplish it, so long as the present customs of caste and modes of life of the inhabitants prevail.

The bearing of this state of affairs upon the policy which the nations of the earth should pursue in the adoption and enforcement of measures to prevent the introduction of cholera and its dissemination among them will be discussed in a later chapter on prevention. It may be remarked in this connection, however, that whilst the various national powers are asked to remove the barriers of quarantine as one of their chief means of defense against invasion by cholera, they should in their own interests and in the interests of international trade demand that a real and earnest effort be made on the part of the Government of India to prevent the escape of this infectious disease at least from the port of Bombay with westward bound pilgrims and European soldiers returning after service in India.

## CHAPTER III.

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### BACTERIOLOGICAL INVESTIGATIONS AND LITERATURE RELATING TO THE DIAGNOSIS AND ETIOLOGY OF CHOLERA.

The more or less complete and exhaustive studies of former epidemics of Asiatic cholera by medical experts in different parts of the world have been limited in the main to questions concerning the nature, symptomology, treatment, and prophylaxis of the disease from the stand-point of the clinical practitioner and the quarantine officer, and the work has been so satisfactorily accomplished in general that it is not deemed advisable again to consider these questions in this report. For the history of former epidemics, the symptoms which characterized the disease, and general considerations concerning therapeutics the student is referred to the numerous former publications: among the most exhaustive treatises concerning these questions, especially for those conversant with the English language alone, the report published by the United States Government upon the cholera epidemic of 1873 can be consulted with great advantage. By the examination of such literature it becomes evident that the infectious nature of the disease, its transportability from place to place, its habit of extending in an epidemic form through the agency of water supplies, personal effects, and articles of food contaminated by discharges from the bowels of cholera patients, the location of the infectious principle in the intestinal contents and the necessity of basing measures of prophylaxis upon these considerations were well determined and appreciated by the vast majority of intelligent physicians the world over as early as the end of the epidemic which closed in 1873.

At the time of the appearance of cholera in Egypt in 1883 nearly every studious physician of experience, whether in this country or elsewhere, was firmly imbued with the belief—arrived at by deduction from a multitude of incontestable facts accumulated in the past—in the existence of a specific material living entity as the primary cause of Asiatic cholera, as also of the vast importance of the discovery of that entity as a preliminary requisite for the most rational and efficient management of outbreaks of the disease and for the judicious selection of effective measures of prevention. It is true, however, that a small minority, including some of the most distinguished sanitarians of the world, have at all times disputed the specific nature of the disease, as well as its transmissibility and transportability. Some of the latter have occupied, and still do occupy, commanding official positions in the sanitary departments under the governments of several of the countries where cholera has at different times committed extensive ravages.

The various scientific investigations which have been made during the last epidemic in different parts of the world have been especially influenced by a firm belief in the existence of a specific agent as the cause of the disease, and have aimed at its discovery. Since the previous epidemic of 1873 the means and methods of exact investigations of this order have been devised and more or less perfectly developed. For the first time in the history of examinations into the cause of this terrible scourge scientists pursuing such studies have been in a position where it was possible to arrive at definite results. Every commission delegated by the differ-



ent Governments, as well also as almost every individual investigator who has given his attention to the study of the last epidemic, have devoted attention chiefly to the etiology of the disease.

When cholera appeared in Egypt in 1883, two of the most powerful European Governments, viz, France and Germany, sent commissions there for the study of the epidemic, composed of the most experienced and accomplished bacteriologists they possessed. The French commission consisted of the most expert assistants of Pasteur—Drs. Thuillier, Strauss, and Roux, and the first-mentioned lost his life in the pursuit of his scientific studies. The German commission consisted of the most experienced bacteriologists in that country—Dr. Robert Koch, then director of the Pathological Laboratory of the Imperial Board of Health in Berlin, with Dr. Georg Gaffky and Dr. Fischer, his chief assistants in that office.

These commissions had not been long at work in Egypt before reports concerning important discoveries began to appear. It was the German commission which succeeded in making investigations which were crowned with most positive results. The epidemic, however, soon ceased in Egypt after the arrival of these commissions, and for the completion of their investigations material for study had to be obtained elsewhere. In consequence of the important preliminary discoveries by the German commission in Egypt they were directed by their Government to proceed to India and continue their work there in the natural home of cholera. As will be seen by reference to abstracts of reports hereafter introduced, the investigations in India made by the German commission confirmed and more fully developed the discoveries which they had previously made in Egypt. The immense importance of these discoveries for the practical recognition of cholera at the commencement of an epidemic, and possibly also for the prevention of the disease, excited world-wide interest, and caused numerous more or less capable investigators to enter upon the study of this question from the bacteriological stand-point in various parts of the world, chiefly in Europe. At first the results of these numerous investigations were somewhat contradictory and tended to create serious doubts as to the genuineness of the discoveries; but subsequent experience has confirmed in the most positive manner the chief essential points set forth in the reports of the German commission concerning their investigations into the etiology of cholera.

For the information of those who desire to obtain the full facts upon which this statement is based but, through unfamiliarity with various foreign tongues in which detailed reports of investigations have been published or through difficulties in obtaining the original documents, the latter are practically inaccessible (since but a small fraction of the literature relating to this subject has appeared in print in the English language, and then usually in the form of short and more or less adversely biased abstracts), more or less complete translations of the most important foreign publications of original investigations relating to this matter have been made and incorporated below.

As has already been stated in our introductory chapter, the most strenuous opposition which the report of the German commission at first met with emanated from Dr. E. Klein and his associates, constituting a commission sent by the British Government to India for the purpose of investigating the ground of the claims advanced by Koch and his confrères. The labors of both of these commissions are set forth below more or less *in extenso*; and it will be seen that the report of the British commission combats that of the German Government, both as to general statements and as to detailed observations. While this is true of the official report which Dr. Klein, as chief of his commission, made to the British Government and which was published by the latter as an official document, this distinguished investigator as a result of subsequent studies has had occasion to announce numerous retractions and modifications of his first opinions, as will be seen by reference to abstracts of his more recent publication relating to the subject of asiatic cholera. It will be seen also by examination of the following abstracts of the literature relating to bacteriological investigations that, as previously stated, the discoveries of Koch and his associates have been amply confirmed in different parts of the world, in many instances even by those who at first antagonized his views. And it may be affirmed that at least in one most important particular the work of the German commission stands to-day

universally unquestioned by any competent authority, viz, as to the existence of a peculiar specific microbe in the intestinal contents of cholera patients, the so-called comma-bacillus of Koch, a germ which is associated with no other known disease either in man or beast. And it can also be declared that the existence of this comma bacillus furnishes an absolutely reliable means of diagnosis of suspicious cases of cholera, the nature of which can not certainly in any other way be determined, except by the unfortunate spread of an epidemic from them. The immense practical value of this discovery, as has been already stated, can not be over-estimated.

Concerning the belief of the German commission that the comma bacillus of Koch is not only the invariable accompaniment of asiatic cholera, but is also the actual specific cause of the disease, besides what bears more or less closely upon this opinion in the following pages of this chapter, we shall have occasion to present further considerations later on in this report when we come to discuss the results of the anti-choleraic inoculations practiced so extensively by Dr. Ferrán and his assistants during the epidemic of 1885 in the Kingdom of Spain.

#### HISTORY OF OPINIONS CONCERNING THE CAUSE OF CHOLERA.

Cornil and Babes (*op. cit.*) give the following very brief but lucid *résumé* of the various notions held by leading writers who have contended for a material living entity as the cause of cholera.

“*History*.—Endemic in India, on the delta of the Ganges, Asiatic cholera, almost always reaches Egypt before arriving in Europe, where in Italy, France, and Spain, in 1884 and 1885, it has made its sixteenth appearance since the beginning of the century; its ravages have always been diminishing since the great epidemic of 1832.

The etiological character of the disease; the transportation of the contagion, principally by travelers, by caravans from Mecca, and infected ships; the very evident contagion from linen soiled by the dejecta, the formation of contaminated places and of endemic localities, by houses, large hospital establishments, and persons, have for a long time given reason for the idea of a parasitic contagion.

Virchow in 1848 (Virchow Archiv, t. xli.), Pouchet, Brittan, and Swayne, in 1849, found vibriones in abundance in choleraic stools, but without attributing to them any specific value, any more than Davaine did for the circomonas which he found under the same circumstances. Boehm (cited by Virchow) and Hallier believed that they had discovered the cause of cholera in a fungus of the genus urocystis, which Hallier thought must exist in some of the species of Indian grain. Klob looked upon cholera as related to the presence of a considerable quantity of fungi located in the intestine; Phillipi Pacini also observed infinitely small organisms, possessed with a molecular movement, very pronounced, in the stools of cholera. Pacini having demonstrated, as Boehm, Cenular, Gull, Bennett, Grainger, etc., had done before him, the desquamation of the epithelium of the intestinal mucous membrane, attributed this desquitation to his colerigenous microbes, and developed a dynamo-physiological and mathematical theory of cholera from this fact, epithelial disintegration following by excess of aqueous transudation.

Researches made upon the bacteria of the intestine, during the epidemic of 1873, did not give any new results. Hayem and Réynaud enumerated in the dejecta a dozen species of vibriones. These were the “spores” which they met with in the rice-water stools, but they did not commit themselves to a specific parasite.



## SECTION 1.

## ETIOLOGICAL INVESTIGATION.

*ABSTRACT OF A PAPER READ BY DR. ROBERT KOCH, AT THE CONFERENCE HELD AT BERLIN, FOR THE DISCUSSION OF THE CHOLERA QUESTION, IN JULY, 1884.\**

We need for sanitary regulations a scientific basis as firmly established as possible; for these regulations have to do not only with very costly management, but also with the well-being of many men. This is more particularly the case as regards the prevention of epidemics, with which, as can be said without any exaggeration, the most important sanitary endeavors are occupied. On this account it might be presumed that the contest against epidemics is waged on scientific principles, which are quite established and carried out; but unfortunately this is not universally the case; and especially with regard to cholera such a firm basis is wanting. Quite a number of views have been propounded as to the nature, the spread, and the mode of infection of cholera, and different theories have been founded thereupon. But opinions are so divergent from each other—some, indeed, are directly antagonistic, that we are unable without further inquiry to accept them as a basis or starting point for our measures for combating this epidemic.

Thus, on the one hand, it is stated that cholera is a specific disease, having its source in India; on the other, this is disputed, and it is said that cholera can rise spontaneously even in other countries, and does not depend on a specific cause. The one side only acknowledges that cholera can be transmitted by the sick and their emanations; the other that it can be carried by merchandise, by healthy men, and by currents of air. Just as contradictory opinions exist as to the importance of drinking water as a vehicle for the infective material, as to the influence of the nature of the soil, as to the question whether or not the dejections of the patient contain the infective material and as to the duration of the stage of incubation. All these points are, however, of the greatest importance in the prevention of cholera, and this disease can not be successfully combatted until some agreement is arrived at with regard to these preliminary questions in its etiology.

The etiology of cholera has indeed been able to profit little from the progress which we have made in the etiology of other infectious diseases. This advance has been principally developed during the last ten years, and during this time no occasion has demanded an inquiry to be made into cholera, at least not in Europe or in the neighboring countries; and in India, where cholera could have given continuous material for investigation, nobody has been found to occupy himself with the task by the help of the recent methods of research.

On this ground it was therefore not unfortunate that last year cholera broke out in Egypt and gave an opportunity for studying the nature and mode of infection of the disease before it spread into Europe. This opportunity was made use of by different Governments, and expeditions were sent there for the investigation of cholera.

The honorable charge of conducting one of these expeditions fell to my lot.

When I undertook this commission I was well aware of the difficulty of the task which lay before me. Absolutely nothing was known with regard to the virus of cholera. One was at a loss where to seek for it, whether only in the intestinal canal, or in the blood, or in some other place. Further, one did not know whether bacteria would have to be dealt with in this case, whether some kind of fungus or the like, or whether some animal parasite such as an amoeba. To be sure the investigation did not in this direction meet with such difficulties as in another where I expected it the least. I had pictured to myself the pathological conditions entirely after the description in the text-books, namely, that the intestine in cholera would show peculiarly little change, and that it would be filled with a material like rice-water. I

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\* Translated by C. Watson Chayne.

had almost forgotten the result of the autopsies which I had formerly seen, so that I was unable to correct from them my erroneous views. I was therefore at first somewhat surprised and uncertain, when I came to see something quite different in the intestine. In the first post-mortem examinations it almost at once became apparent that in an overwhelming majority of cases remarkably deep and striking changes existed in the intestine; the other cases again showed changes less serious; and lastly, I came across cases which corresponded in some measure to the type which is described in the text-books. But it required time and a number of post-mortem examinations as well before I succeeded in forming a correct general idea and in estimating rightly all the different changes which came before me.

I shall here remark that in spite of the most careful examination of every other organ, and of the blood, nothing was found which warranted the inference to be drawn that there existed any virus in them. The interest was therefore directed finally to the changes existing in the intestine, and these might be roughly grouped in the following manner: There were cases in which the lower segment of the small intestine was stained of a dark brownish red color, most intense immediately above the ileo-cæcal valve and diminishing upwards, the mucous membrane being studded with superficial hemorrhages. In many cases the mucous membrane was even superficially necrosed and covered with a diphtheritic deposit. In such cases the contents of the intestine were not a rice-water like and colorless, but a bloody ichorous, offensive fluid. Other cases again showed a gradual transition to less deep changes, the reddening being less intense or only in patches; and finally there were cases in which only the margins of the follicles or Peyer's patches were reddened. This last-mentioned group presented a very characteristic appearance, which scarcely ever occurs in other intestinal diseases and which is quite peculiar to cholera. In a very few cases, however, was there extremely little change in the mucous membrane, which appeared somewhat swollen and less transparent in the superficial layers, the solitary glands and Peyer's patches being more strongly marked. The whole mucous membrane was colored a light rosy red, but it never went so far as capillary hemorrhage. In these cases the intestinal contents appeared colorless, though they never could be compared to rice water, but rather with gruel. Only in a very few cases did I see the contents of the intestine composed of clear water and mucus, with comparatively little flocculent matter in suspension.

If the intestine and its contents were microscopically examined it then appeared that in some cases, particularly in those in which the Peyer's patches were reddened at the edges, this redness corresponded to the migration of bacteria. It gave an appearance like what you have seen in one of the preparations before you, which was taken from such a case. The bacteria had partly crowded into the tubular glands, and had partly thrust themselves between the epithelium and the basement membrane and thus had, as it were, detached the epithelium; in other places they appeared to have penetrated deeper into the tissues. Then there were cases in which, behind these bacteria (which because of their size and shape and a definite appearance, so that they could be distinguished from other bacteria and have special attention devoted to them), various other bacteria penetrated into the tubular glands and the surrounding tissues; for example, large thick bacilli and very fine bacilli. Similar conditions are found in necrotic and diphtheritic changes of the intestinal mucous membrane and in typhoid ulcers, where the tissues destroyed by the pathogenic organisms are afterwards infiltrated with other non-pathogenic bacteria. These first-mentioned bacteria could not therefore be considered *à priori* as altogether unimportant in the cholera process while all the others gave the impression that they were secondary; for the first described bacteria always preceded these latter; they penetrated deeper into the tissues and appeared as if they had opened a way for the other bacilli.

Now as to the contents of the intestine. At first the cases examined were scarcely suitable and afforded no clear picture, for the contents of the intestine had already a decomposed bloody character. In these cases were innumerable quantities of the most different kinds of bacilli, so that the attention could not be fixed on the special cholera bacillus. It was only after I had performed autopsies on a few acute and uncomplicated cases in which hemorrhage had not yet occurred, and in which the intestinal contents had not yet become decomposed, that I recognized that the purer and fresher the cases were the more a definite kind of bacteria pre-



vailed in the intestinal contents; and it very soon became evident that these were the same bacteria which I had previously seen in the mucous membrane. This discovery, it stands to reason, drew more and more the attention to this species of bacteria. I have examined them from every point of view to determine their special peculiarities, and can communicate the following about them :

These bacteria, which, on account of their peculiar form, I have named comma bacilli, are smaller than the tubercle bacillus. As a precise idea of the size, length, and breadth of bacteria can scarcely be got from a statement of the dimensions in numbers, I prefer to compare the dimensions of bacteria with some well-known object, so that a fairly accurate idea can be obtained. As the tubercle bacilli are known to all, I shall compare the cholera bacteria with them. The cholera bacilli are about half, or at the most two-thirds, as long as the tubercle bacilli, but they are plumper, thicker, and furnished with a slight curve. This curve is usually not more marked than that of a comma, but under certain circumstances it can become more pronounced, and even may form a semi-circle. Other cases are seen in which the curve is double; one comma may join another, but in an opposite direction, so that the letter S is formed but I believe that in both cases two individuals remain in connection with each other after division, and thus cause the appearance as if there was a more marked curvature. In the cultivations there is found a very noteworthy form of development of the comma bacilli which is very characteristic. In one of the preparations which have been laid before you there are several well-marked examples of this form, and I took the opportunity, in the demonstration of these preparations, to draw particular attention to them. The comma bacilli frequently form threads of greater or less length. These threads are not straight, as are those of other bacilli—for example, the anthrax bacilli—nor simple undulating threads, as might be thought from the microscopic characters; but are long, delicate spirals, which in their length and other appearances have the greatest resemblance to the spirochætæ of relapsing fever. I should not be able to distinguish them from each other if they were placed side by side. On account of the peculiar form of development I am inclined to the view that the comma bacillus is not really a true bacillus, but an intermediate form between the bacilli and the spirilla. Possibly even it may be a true spirillum, of which we have a fragment before us. In other spirilla—for example, the *spirillum undulans*—it is seen that short specimens do not form a complete spiral, but consist of a short rod which is more or less curved. Later I shall return to this point, which is not altogether unimportant.

From the demonstration of the preparation in which the comma bacilli were cultivated in meat infusion you have already learned that they can be grown in that material. They increase in this fluid extraordinarily quickly and luxuriantly, and this circumstance can be utilized to study their other properties by suspending a droplet of meat infusion, in which these organisms are growing, from the under surface of a cover glass and examining it directly with a high power. It is then seen that the comma bacilli are extraordinarily active in their movements. When they accumulate in numbers at the margin of the droplet, and are swimming about actively, it seems quite as if there were a swarm of midges, between which dive here and there long spiral-shaped threads, which have themselves pretty active motion. The whole forms a peculiar and in the highest degree characteristic picture.

The comma bacilli also grow in other fluids, and they especially develop in milk very rapidly and luxuriantly. They do not cause the milk to curdle nor do they separate the casein, as many other bacilli do, which have equally the property of developing in milk. The milk appears quite unchanged, but if a small drop be taken from the surface and examined microscopically it swarms with comma bacilli. Further, they grow in blood serum, in which they develop very rapidly and increase luxuriantly. A very good soil for the comma bacilla is the nutrient jelly, of which you have already seen a specimen. This nutrient jelly is also of use, as I have explained in the demonstration of the method of cultivation, for rendering the discovery of the comma bacilla easier and extremely certain. In nutrient jelly the colonies of the comma bacilli take quite a characteristic and definite form, which, as far as I have investigated and as my experience goes, is like that formed by no other kind of bacillus.

The colony appears, when it is quite recent, as a very pale and tiny drop, which is not completely circular, as is usually the case with colonies of bacteria in gelatine. They have a contour more or less irregularly defined, with projections in parts, giving a rough or dentated appearance. They also assume very early a somewhat granular character, and are not of homogeneous consistence like most other colonies of bacteria.

As the colony become somewhat larger the granulations become more apparent, till finally it appears as a little mass of highly refracting granules. I would compare the appearance of such a colony best with that of a heap of bits of glass. On further increase of the colony the gelatine in its immediate neighborhood becomes fluid, and at the same time the colony of bacteria sinks somewhat deeper into the substance of the gelatine. Thus there is formed a small funnel-shaped recess in the gelatine, in the middle of which the colony can be recognized as a small white point. This appearance is quite peculiar, at least it is seen in very few other forms of bacteria, and according to my knowledge is never so distinctly marked as in the comma bacilli. This sinking in of the colony can be most clearly observed if a pure cultivation is prepared exactly in the way which has been described in the demonstration of the cultivation process. A suitable colony should be looked for under a low power in the layer of gelatine. This should be touched with a platinum wire which has been previously heated; the bacilli should be transferred on the wire to a test tube filled with gelatine, which is then plugged with sterilized cotton wool. A pure cultivation made in this manner grows in the same way as in the gelatine on the glass plate. I possess a large collection of pure cultivations of bacteria prepared in this way, but I have never seen in them such changes as those which the comma bacillus causes after its transfer to the gelatine. As soon as the cultivation begins to develop a small funnel is noticed, which indicates the top of the needle track. (See Fig. 10.) Gradually the gelatine in the neighborhood of this track becomes fluid, and there is clearly seen the small colony, which is ever enlarging. A deeply sunken spot, however, always remains, which appears in the partially fluid gelatine as if a bubble of air floated over the colony of the bacilli. It almost gives the impression as if the vegetation of the bacilli had not only caused the liquefaction of the gelatine, but also a rapid evaporation of the fluid formed. We know already a number of different bacteria which cause the gelatine in test-tube cultivations to become fluid in just the same manner around the track of inoculation. But such a depression and bubble-shaped hollowing out of the surface is never found. I have still to mention that the liquefying of the gelatine from a single isolated colony never extends far, as can be best demonstrated in a layer of gelatine spread upon a glass plate. The dimensions of this liquefied area around a colony may be estimated at about one millimeter. Other kinds of bacteria are able, as you have seen in one of the gelatine plates laid before you, to liquefy the gelatine over a greater area, so that a colony may extend to a centimeter or more in diameter. In the cultivation of the comma bacilli in test tubes the liquefying of the gelatine spreads gradually and very slowly from the track of inoculation, so that in about a week the entire contents of the tube become fluid. To all these peculiarities, trivial as they appear by themselves, particular weight should be attached, because they serve to distinguish the comma bacilli from other varieties of bacteria.

Further, the comma bacilli can be cultivated when placed in agar-agar, to which meat infusion and peptone has been added. This agar-agar jelly is not liquefied by the comma bacilli. They can also be grown on boiled potatoes, and in regard to certain questions this is a very important point. They grow on potatoes just like the bacilli of glanders. These last, as you have perhaps seen in the cultivations demonstrated at the Hygienic Exhibition, form a thin pap-like brownish layer on the potatoes. The cultivation of the comma bacilli, if grown on potatoes, is similar to this, but it is not colored such a deep brown, but rather a light grayish brown.

The comma bacilli thrive best at a temperature of from 30° to 40° C., but they are not very sensitive to lower temperatures. Experiments have been made, which have shown that they do quite as well at a temperature of 17° C., though they grow correspondingly slower. Under 17° C., the growth is very slight, and under 16° C. it seems to stop altogether. In this



respect the comma bacilli correspond in a noteworthy manner to the anthrax bacilli, which also require about the same limits as regards low temperature. I once made an experiment as to the influence of lower temperatures upon the comma bacilli, to discover if it were possible not only to delay their development by a very low temperature, but even to destroy them. For this purpose a cultivation was placed for an hour in a temperature of  $10^{\circ}\text{C.}$ , which completely froze it. Then a cultivation was made therefrom in gelatine, but this showed in its development and growth not the slightest difference. It bore freezing perfectly well. Not so is it with the deprivation of air and oxygen. It stops growing at once if it is deprived of air, and therefore if one accepts the division of aerobic and anaerobic organisms it would belong to the anaerobic. One can easily convince oneself in this way. After the inoculated jelly has been poured out on a glass plate, and when it has just begun to solidify, a piece of glass (Marienglass), or mica split as thin as possible, is laid on the middle of the gelatine so as to cover at least one-third of the surface. The leaf of mica, on account of its elasticity, adapts itself accurately to the surface of the gelatine, and shuts off the air from the covered portion. It is then seen, as soon as the development of the colonies commences, that it occurs only in the uncovered portion of the gelatine, and reaches very little under the cover, to the extent only of about 2 millimeters, as far in fact as the air can penetrate by diffusion; but under the mica plate nothing grows. There certainly exist extremely small colonies invisible to the naked eye, which apparently owe their existence to the oxygen contained in the jelly, but these do not increase in size much further after this is exhausted. An experiment was also made in another way. A small glass containing nutrient jelly, which was inoculated with comma bacilli, was placed under the receiver of an air-pump, another glass prepared in a similar way was placed outside the air-pump, as a control experiment. It then appeared that those under the air-pump did not grow, while those outside the pump did well. But if those which had been under the air-pump were afterward set out in the air, they then began to grow. They therefore had not died, but only wanted the necessary oxygen to be able to grow. The result is similar when cultivations are placed in an atmosphere of carbonic acid; while those cultivations placed for control outside the carbonic acid atmosphere grow in the usual manner, those subjected to a stream of carbonic acid remain without development. However, in this case also they do not die, for after they have been left in the carbonic acid for a considerable time they begin at once to grow as soon as they are taken out of it.

Taken as a whole the comma bacilli increase, as I have several times indicated, extraordinarily rapidly. Their vegetation reaches its highest point very quickly; it remains stationary only a short time, and then quickly diminishes. The dying comma bacilli lose their form; they appear at times shriveled, at times they have a more swollen aspect. Also in this state they take up coloring matter faintly or not at all. The peculiar conditions of the growth of the comma bacilli can be best observed, if substances which are rich in comma bacilli, but which contain other bacteria, such, for example, as intestinal contents or cholera dejections, are placed on moist earth or spread on linen and kept in a moist condition. The comma bacilli increase in a remarkable manner in a short time, for instance, within twenty-four hours. The other bacteria occurring alongside them are in the first instance overgrown by them. A natural pure cultivation is thus formed, and there are obtained, by microscopic examination of portions taken from the surface of the moist earth or linen, preparations which show almost only comma bacilli. You have seen such a preparation obtained from the linen of a cholera patient which was soiled with dejecta and kept moist. The luxurious growth of the comma bacilli does not, however, last very long. After two or three days they begin to die, and the other bacteria then increase in number. These circumstances are similar to what goes on in the intestine itself. A rapid growth takes place, but when the period of vegetation, which lasts only a short time, is over, and especially when there is transudation of blood into the intestine, the comma bacilli disappear again, and in their stead other kinds, especially putrefactive bacteria, develop. On this account I would almost assume, *a priori*, that if the comma bacilli are introduced into a putrid fluid containing much of the products of decomposition of other bacteria, and in particular of putrefactive bacteria, they would not develop properly,

but would soon die. Upon this point, however, exhaustive experiments have as yet not been made, and it is only a conjecture I should make on the ground of experience gained in the cultivation of other bacteria. This point is of importance so far, because it is not altogether a matter of indifference whether the comma bacilli, when they get into a cess-pool, will there find a good or a very bad soil. In the first case they would increase, and must be destroyed by disinfection; in the latter they would die, and the cess-pool would need no further disinfection. According to all the experience I have at my command I am inclined to accept the latter view.

The comma bacilli thrive best in fluids which do not contain too little nourishing material. Several experiments have been made as to this point. A meat infusion, with an alkaline reaction, was diluted and inoculated with comma bacilli. In one of these experiments the meat infusion, after being diluted five times, proved itself to be no longer a suitable medium. In another the comma bacilli grew even after a tenfold dilution. It stands to reason that these experiments must be performed again and carried out on a more extensive scale, in order to find a certain limit; but in any case this result was recognized, that the dilution could not go very far, and that the comma bacilli required a certain concentration of the nourishing material for growth.

In the cultivation experiments it was further found that the nourishing material, at least the nutrient jelly and the meat infusion, should not be in the least acid. As soon as the nutrient jelly showed the slightest trace of an acid reaction, the growth of the comma bacilli became very much diminished. Did the reaction become clearly acid, then the development completely stopped. However, it is worthy of note that not every acid appeared to be antagonistic to the comma bacilli, for the cut surface of a cooked potato gives a marked acid reaction due to the presence of, if I do not mistake, pyromalic acid (apfelsaure), in spite of which the comma bacilli grow quite luxuriantly. So that it can not be said without further inquiry that all acids hinder the growth, but in any case there is a number of acids which have this property, and in the meat infusion it is probably due to the lactic acid, or an acid salt of phosphorus.

Since the influence of development-inhibiting substances on the growth of the comma bacilli is of no small interest, a number of other substances were investigated. At this stage I should like to draw attention to the fact that the inhibition of the development does not imply disinfection, and these experiments only deal with the determination of the amount of a substance which suffices to hinder the growth of the bacteria. In no way are they killed as they would be in disinfection. We had something analogous to these experiments in the influence of carbonic acid on the comma bacilli, in which only so long as the carbonic acid was allowed to act, was the growth inhibited. So, also, for a number of substances which I shall enumerate to you.

Iodine has been shown by Davaine to be a very intense poison to bacteria, and in certain circumstances this is quite correct. Davaine made the experiment in this manner: He diluted a fluid, which contained anthrax bacilli (for example, the blood from this disease) to an extreme degree, so that he had practically only pure water, in which were suspended a very few anthrax bacilli. To this fluid he added iodine, and it was shown that the bacilli were killed by this in extraordinarily small quantities. But the conditions in practice are quite otherwise. We have never to stop the growth of infective materials in pure water, but in the alkaline contents of the intestine, or in the blood or in lymph, and in these the iodine would not remain free but would immediately form a combination with the alkalies. The testing of the influence of iodine on the comma bacilli was carried out by adding iodine water to a meat infusion, which was carefully prepared so as to form a good nourishing material. Iodine was dissolved in water in the proportion of about 1 to 4,000. Of this iodine water 1 cubic centimeter was mixed with 10 cubic centimeters of the meat infusion, but this addition did not hinder the development of the bacilli in the slightest degree. The proportion of iodine which will prevent the bacilli from developing would have to be far greater than that used in the experiment. Therefore it did not appear to me to be necessary to perform further experiments, since in practice a greater amount of iodine than this could not be given.



Alcohol first prevents the development of the comma bacilli when one part is added to ten of the cultivating fluid, that is, to the extent of 10 per cent. This is a degree of concentration which in any case can not be made practical use of.

Common salt was used to the extent of 2 per cent. without any hindering of the growth of the comma bacilli being caused. Sulphate of iron prevented development first on 2 per cent. being added to the cultivating fluid. As this material has frequently been used for disinfection during cholera times, I would impress on your memory that 2 per cent. strength is the first limit to hindrance to development, and that by this concentration sulphate of iron does not kill the comma bacilli. The power of sulphate of iron in preventing development depends upon the fact that, on its addition to the cultivating fluid the peptones and the albuminates, which serve for the nourishment of the bacteria, are precipitated, for a copious precipitate occurs on the addition of a 2 per cent. addition of sulphate of iron. Possibly also the acid reaction comes into play in hindering the growth. A specific action on bacteria does not therefore seem to be possessed by this material, and it is not a real destroying or disinfecting material. I consider it even possible that, with a material of this kind, quite the contrary result may be obtained to what is intended. Given the case in which the contents of a cess-pool, into which it is supposed that the comma bacilli have entered, have to be disinfected, according to my idea the putrefactive process going on in the material is quite sufficient of itself to kill the comma bacilli. But if iron sulphate is added to such an extent as to cause an acid reaction, and thus to interrupt the putrefactive process, nothing occurs, except the cessation of the growth of the bacteria, as well as the comma bacilli, the prejudicial influence of the septic bacteria being taken away, they will be preserved instead of being destroyed.

This instance is a very good one as showing that the disinfectant must be accurately estimated and tested on this point, and that one has to carefully decide what acts only as a preventive to decomposition, and what is really destructive to the bacteria. Possibly the first may even serve as a preservative to the infective material.

I shall go over only shortly the proportion of other substances necessary to inhibit the development. Alum, 1 to 100; camphor, 1 to 300; I had particularly expected from camphor a stronger action, but several careful experiments have shown that this substance possesses only a slight influence on the comma bacilli. Carbolic acid, 1 to 400; this number agrees roughly with what we previously knew of carbolic acid and other bacteria. Peppermint oil, 1 to 2,000; sulphate of copper, 1 to 2,500; this material has a fairly strong effect, but if one calculates how much sulphate of copper must be given to hinder the growth of the comma bacilli in the intestinal canal, one would arrive at a quantity which it would be impossible to administer to anybody. Quinine, 1 to 5,000; and corrosive sublimate, which here again is found to be far superior to all other substances, 1 to 100,000.

In these experiments as to the influence of development-inhibiting materials, the surprising fact was established that the comma bacilli extraordinarily easily die when they are dried. The experiment was done by allowing a small droplet of a substance containing bacilli to dry on a cover-glass (indeed for a series of experiments a large stock of such cover-glasses should be prepared). On such a cover-glass a small drop of the fluid to be tested is placed, and the development is then studied in a hollow slide. By proceeding in this way it was found that in not a single preparation was there any growth, but what was more remarkable, there was none in the control specimen, in which the fluid employed was pure meat infusion. At first I did not at all know on what the non-appearance of the growth depended, and thought that the cause must lie in the meat infusion, for in similar experiments with other bacteria I had never met with any thing of the kind. For example, the anthrax bacilli can be kept for a considerable time dry on cover-glasses, and in this state they remain capable of growth from a half to a whole week. As the examination of the meat infusion showed that the fault was not due to it, we had to test whether the comma bacilli had not been destroyed through the process of drying on the cover-glass. To get information on this point the following experiment was performed: A number of cover-glasses were provided with a droplet of some bacillus-holding material. The droplet dried up after a few minutes. Then one cover-glass after a quarter of an hour, another after half an hour, another after an hour, and so forth, had placed upon it a

drop of meat infusion. It then became apparent in the several series of experiments which were made, that the comma bacilli on the glasses dried for a quarter of an hour, for half, and for a whole hour were capable of development, but that many of those dried for two hours were dead. In none of these experiments did the bacilli retain their vitality for more than three hours. It was only when compact masses of bacillus cultivation (for example, the pap-like substance of a cultivation grown upon potatoes) were dried, that the bacilli remained alive for a longer time, evidently because in these cases complete dryness occurred very much later. But even under these circumstances the bacilli have never been found to retain their vitality in a dry state longer than twenty-four hours.

This result was in so far important, for with its help it was easy to test whether the bacteria had a resting stage (*dauerzustand*). We know that other pathogenic bacteria which form spores, for instance, anthrax bacilli, can be preserved in a dry state in their resting or spore condition for years on a cover-glass without dying. We know also of other infective materials, with the nature of which we are not yet precisely acquainted, for example, variolous or vaccine matter, that they can remain active in a dry state for a long time, even for several years. These cases depend on the existence of a real resting stage. If, then, the comma bacilli, which are destroyed in such an unusually quick manner by drying, exist in a resting stage under any conditions, this fact must very soon be made evident by drying them.

In any case this is one of the most important questions in the etiology of an infective disease, but particularly so for cholera. On this account the investigation of this point has been carried out in the most careful way possible and in all directions, and I believe there is scarcely anything more to be done in reference to it. First, the cholera dejecta and the intestinal contents of cholera cadavera were placed on moistened linen, in order that the comma bacillus might be able to develop under the most favorable conditions. After different periods pieces of the linen were dried, as, for instance, after twenty-four hours, after some days, after several weeks, in order to see if in this time anything like a resting stage had been formed. For the infection by cholera linen affords the only undisputed example of the existence of an active infective material which is attached to a definite object. If a resting stage is to be found anywhere it must exist in the linen soiled by cholera patients.

In all these experiments, however, a resting stage has never been demonstrated. When the dried materials were examined it was found that the comma bacilli were dead. Further, the dejecta were put into the ground, either mixed with the soil or spread over the surface of the earth, which was either kept dry or moist; also, they were mixed with marsh water and left to decompose without anything further being added. In gelatine cultivations the comma bacilla have been cultivated as long as six weeks; the same in blood serum, in milk, and on potatoes, on which the anthrax bacilla, as is known, form spores extremely quickly and abundantly. But a resting stage of the comma bacilli has never been met with. Since we know that most of the bacilli possess a resting stage this result must appear very surprising. But I shall here call to recollection what I have already mentioned earlier, that it is in the highest degree probable that we have here to deal with a micro-organism which is not a true bacillus, but which is more closely related to the group of spiral bacteria, the spirilla. But we do not, however, know that any of the spirilla have a resting stage. Spirilla are bacteria, which are always associated with fluids, and do not, like anthrax bacilli, grow under conditions in which they have to exist at times in a dry state. It seems to me, therefore, at least as far as my experience goes, that one can not expect to find a resting stage for the comma bacilli. Besides, as I shall have to explain later, the want of the resting stage is completely in accordance with the experience of the etiology of cholera.

If all the peculiarities of the comma bacilli as yet described are taken into consideration, one must come to the conviction that they belong to a definite, clearly characterized kind of bacteria, and that they may be easily recognized and distinguished from other bacteria by the aid of their characteristic properties.

After this conviction was come to, it was necessary to determine in what relation the comma bacilli stand to the true cholera process; and in the first place it was necessary to inquire whether they occur in all cases of cholera and whether they are wanting in all non-



cholera cases—that is to say, whether they belong exclusively to cholera. From this point of view, as large a number of cases as possible have been thoroughly examined. In Egypt 10 post-mortem examinations could be utilized, though these were only microscopically tested, for the characteristics of the common bacilli, as shown by their growth in nutrient jelly, were not at that time sufficiently well known to me to enable me to use the gelatine process for the demonstration of the bacilli. But I have convinced myself by careful microscopical examination that the comma bacilli were present in all these cases. Then in India 42 autopsies were examined microscopically, as well as by cultivation in nutrient jelly, and in no case were the comma bacilli absent. In a number of cases having an acute course almost a pure cultivation of the comma bacilli was found in the intestine. Further, in India the dejections of 32 cholera patients were examined in like manner, and in each case the comma bacilli were demonstrated therein. Also vomited fluids from cholera patients were very often examined, but in these the comma bacilli were only found twice, and in these cases the character of the vomit showed that it was not the true stomachic contents, but the contents of the intestine which had been driven up by the pressure of the abdominal walls and so evacuated, the fluid having an alkaline reaction and quite the appearance of intestinal contents. I have also found the comma bacilli in preparations made from eight other autopsies, part of which I had had sent to me previously from India and part I had received from Dr. Kartuhi and Dr. Schiess Bey from Alexandria; and lastly, I made a short time back two autopsies in Toulon conjointly with Dr. Strauss and Dr. Roux, and in these cases, as well as in the dejections of two other cases, the comma bacilli were discovered. In both the autopsies in Toulon extremely characteristic and acute cases were dealt with. The one, a sailor, was to be dismissed from the hospital on that day as convalescent from malaria; he did not, however, go out, for about 11 o'clock in the forenoon he was attacked by cholera; at 3 o'clock in the afternoon he was dead, and the post-mortem examination was made at half past 3 o'clock. I shall take this opportunity of remarking that in almost all the cases examined by me the autopsies were made very shortly after death. In several cases the autopsy was made directly after death, and in most cases only two or three hours after, so that the post-mortem decomposition could not yet have altered the condition of the intestine and its contents. In the above-mentioned case, as well as in a number of former autopsies, it was very evident that in acute cases almost a pure cultivation of common bacilli were present in the intestines. I was able to demonstrate these facts to Drs. Strauss and Roux, who had not yet succeeded in discovering the comma bacilli either microscopically or by means of cultivation on the solid materials. Dr. Strauss informed me that they always thought that there was some knack in the process of coloring and cultivating the comma bacilli. They have, however, convinced themselves that there is nothing simpler if only a pure and uncomplicated case is chosen for examination.

Also in the second fatal case which was investigated at Toulon the comma bacilli were found in the intestine almost in a pure cultivation. At this opportunity I begged Dr. Strauss to demonstrate the microbe, which according to his statement existed in the cholera blood. But in neither case could these bodies be found.

If we reckon all these cases together they come to nearly 100, which were examined for the presence of the comma bacilli, and in all the cases were they found. But the investigation has not only proved that they were present, but, as I have already indicated, they always stand in a direct relation to the cholera process itself. For where the true cholera process causes the most marked changes in the intestine, namely, in the lower half of the small intestine they were found most numerous, above they diminished more and more. In the most typical cases they appeared almost as a pure cultivation. But the older the cases were and the more the secondary changes had taken place in the intestine so much the less numerous were the comma bacilli.

From the choleraic matter investigated by me up to the present time I believe I can now affirm that the comma bacilli are never absent in cholera. They are something specific to cholera.

For purposes of control a large number of other cadavers, dejecta from the sick and the healthy and other substances containing bacteria, have been examined in the same manner, to

find out if these bacilli, though they are never wanting in cholera, might perhaps also be present elsewhere; a point which is of the greatest importance in deciding the casual connection between the comma bacilli and cholera. Among the objects which were examined were the body of a man who had had cholera six weeks previously and had died of anæmia. In his intestine there was absolutely no trace of the comma bacilli to be found. Further, the dejecta of a man were examined who had had an attack of cholera 7 or 8 days previously, and in whom the evacuations had already begun to be more solid. In this case, also, the comma bacilli were wanting. In order to convince myself that the comma bacilli only occur in cholera, I have thoroughly examined more than 30 cadavera. For this purpose I chose, principally, the bodies of those who had died of some intestinal affection, such as dysentery, or intestinal catarrh, so frequently fatal in the tropics; also cases of ulceration of the intestines, a case of typhoid, and several cases of typhus. In this last-mentioned disease the changes in the intestine were at first sight very similar to those which occur in cases of cholera running a severe course with hemorrhage in the intestine. The small intestine in its lower segment was infiltrated with hemorrhages, but it was worthy of note that Peyer's patches were much more changed in typhus than in cholera where they show only the slightest changes. In all those cases, which were principally intestinal diseases, there were never any of the comma bacilla found, and experience taught that these kind of intestinal affections especially predispose to attacks of cholera. It was therefore to be expected that the comma bacilli, if they occur anywhere, would be found especially in such cases; besides, a large number of evacuations from dysenteric patients were examined without finding the comma bacilli in any of them. These investigations I have continued later in Berlin in conjunction with Dr. Stahl, my untiring fellow-worker, from whom much was expected in bacterial investigations, but whose activity death has unfortunately brought to an early termination. We tested, for the presence of the comma bacilli, a large number of evacuations, chiefly from the diarrhea of children, but also from that of adults; further, we tested the saliva as well as the material, rich in bacteria, adhering to the teeth and the tongue, but always with negative results. After that different kinds of animals were examined. Because in arsenic poisoning there appears a group of symptoms very like those of cholera, animals were poisoned with arsenic and afterwards examined. A number of bacteria were found in the intestine but no comma bacilli, nor were they found in the sewage from the town of Calcutta in the extremely impure water of the river Hughli in a number of tanks which were situated in the villages and between the huts of the natives and which contained very dirty water. Wherever I could obtain a fluid containing bacteria I have examined it for the presence of the comma bacilli, but I have never found them. Only once in the water, which at flood time overflows the lands near the salt-water lakes lying to the east of Calcutta, have I met with a kind of bacteria which at first sight had a certain resemblance to the cholera bacilli, but on more exact examination it appeared larger and thicker and its cultivation did not liquefy gelatine. Besides this observation I had already at my disposal a pretty considerable experience of bacteria, but I can not call to my recollection that I have ever seen previously any bacteria which resembled the comma bacilli. I have spoken with many who have made a large number of cultivations and have had much experience, but they have all declared to me that they have not yet seen such a form of bacteria. I believe, therefore, I can say with certainty that the comma bacilli are the constant companions of the choleraic process, and that they are present nowhere else.

It will be now time to answer the question: What can we suppose to be the connection between the comma bacilli and the choleraic process? In answering this question, three different propositions can be advanced. First, it may be said that the cholera process is favorable to the growth of the comma bacilli, because it provides a soil for them, and as a consequence a surprising increase in this kind of bacteria takes place. If this assertion is made, then one must go upon the supposition, that everybody has the comma bacilli in himself, before he has the cholera, for they have been found in the most different places, in India, in Egypt, and in France, and in men of the most different race and nationality. According to this supposition this kind of bacteria must be one of the most widely spread and the most common. But the



opposite is the case, for they occur, as we have seen, neither in those who suffer from other diseases, nor in healthy people, nor apart from man in places most favorable for the development of bacteria. They always appear only when cholera has broken out. This proposition can not be considered as admissible, and therefore we must let it drop.

Secondly, one may attempt to explain the regular coincidence of the comma bacilli and the cholera process thus: That during the disease conditions arise, in consequence of which, among the many bacteria which are present in the intestine, one or other undergoes alteration and assumes the form and peculiarities which we have learned to recognize as belonging to the comma bacillus. With regard to this explanation I must confess that it is without any foundation, in fact, and is a pure hypothesis. We do not know such a change of one kind of bacteria into another. The only example of change in the peculiarities of the bacteria affects their physiological and pathogenic action, but not their form. The anthrax bacilli, for instance, lose their pathogenic action if they are treated in a certain way, but they remain quite unchanged in their form. In this example, then, we have to do with a loss of their pathogenic properties. But this is exactly the contrary to what would take place, if the harmless intestinal bacteria changed to the dangerous cholera bacilli, and of this kind of alteration, viz, from harmless to hurtful bacteria, there does not exist one well-authenticated example. Some years ago, when bacteric investigation was yet in its infancy, one might have suggested such a hypothesis with some degree of justification; but the more the knowledge of the bacteria has advanced, the more it has become apparent that as regards their form the bacteria are extraordinarily constant. In reference to the comma bacilli specially, I shall here notice, that if they are grown outside the human body they retain completely all their previously described characters. For instance, they were cultivated in jelly to the twentieth cultivation, and if they had not been as constant in their properties as other bacteria, they would have returned in the course of this experiment to the usual form of the ordinary intestinal bacteria. But this was in no way the case.

There now remains only the third proposition, namely, that the cholera process and the comma bacilli stand in direct dependence on each other, and with regard to this I know no other explanation than that the comma bacilli cause the cholera process; that they precede the disease, and cause it. The reverse of this—that the cholera process produces the comma bacilli—might be advanced, as I have explained; but this, as was shown, is not possible. To me it is proved that the comma bacilli are the cause of cholera.

But it can be fairly demanded that, if this be so, further proof should be brought forward, and above all things, that the cholera process should be produced experimentally by the comma bacilli. To satisfy this demand attempts have been made in every possible way. The only possibility of obtaining such direct proof of the cholera-engendering action of the comma bacilli is afforded by experiments on animals, which, if one could give credence without reserve to the statements of authors, should be possible without any difficulty. It has been stated that cholera attacks cows, dogs, cats, poultry, elephants, and many other animals, but if these statements are examined somewhat more minutely, it will be found that they are altogether untrustworthy. Up to the present time we possess no really trustworthy example at all of the lower animals being spontaneously affected by cholera during cholera epidemics. Further, all the experiments, which have been made up till now with choleraic material on animals, either have turned out directly negative, or, when they were stated to be positive, were only so nominally, for the evidence was not complete, or was upset by other experimenters. In spite of this we have experimented on animals in the most thorough manner. In particular, because much importance is attached to the results on white mice obtained by Thiersch, I took with me fifty white mice from Berlin, and performed on them every kind of infection experiment. They were fed more especially with the evacuations of cholera patients and the intestinal contents of cholera cadavera. We carried out the method of research of Thiersch as accurately as possible, and used as food not only the material when fresh, but also after it had become decomposed. Although these experiments were performed over and over again with material from different cholera cases, our mice remained quite healthy. Then monkeys were experi-

mented on, as well as cats, dogs, poultry, and various other animals which were available, but we have never been able to obtain any thing like the cholera process. In the same way we experimented with the cultivations of the comma bacilli, and used them as food in every stage of their development. We also found that when we fed animals on large quantities of the comma bacilli, then killed them, and searched the contents of their stomach and intestine for comma bacilli, that the comma bacilli were destroyed in the stomach, and did not usually reach the intestine. Other bacteria behave differently under these circumstances, for there was accidentally discovered at Calcutta a micrococcus, giving a beautiful red color, which, on account of its striking color, was easy to recognize, and therefore was particularly suitable for such an experiment. This micrococcus, at my suggestion, was used as food for a mouse by Dr. Barclay, of Calcutta, and the intestinal contents of the animal were placed on potatoes. There again red colonies of micrococci were found, showing that it had passed through the stomach of the mouse uninjured. The comma bacilli, on the contrary, are destroyed in the stomach of animals. As it had to be decided whether the failure of the feeding experiment depended on this peculiarity of the comma bacilli, the experiment was altered and the substances introduced directly into the intestine of the animals. The abdomen was opened and the fluid was injected directly into the small intestine by a subcutaneous syringe (Pravaz's). The animals bore this interference very well, but they did not become ill from it. Then we tried in monkeys to throw the cholera dejections as high up as possible in the intestine through a long catheter. This was easily done, but the animals remained well. Also, I have to mention that purgatives were first given to animals to excite a certain amount of irritation in the intestine, and then the infective substance was introduced without a different result being obtained. The only experiment in which the comma bacilli showed a pathogenic effect, and which therefore made us hope at first that some result might be got from it, was the injection of pure cultivations directly into the circulation of rabbits and into the abdominal cavity of mice. The rabbits appeared to be very ill, though they recovered again after a few days. The mice, on the other hand, died, after from twenty-four to forty-eight hours, and comma bacilli were found in their blood.

One must, of course, use a fairly large quantity in animals, and it is not as in other infective experiments, which require only the use of the smallest amount to obtain a result. As regards the possibility of being able to infect animals with cholera, I have inquired all over India to obtain evidence of a similar disease being observed in animals, but I have been assured that even in Bengal nothing of the kind has ever occurred. In this province there is an extremely dense population and many kinds of domestic animals, and it must be allowed that in that country, where cholera is universally and continually present, animals, just as often as men, get the infective material of cholera into their digestive canals in quite as active a form; but it has never been observed that animals fall ill with attacks like cholera. I believe, therefore, that not only all those animals which are at our disposal for experimental purposes, but those which commonly come in contact with mankind, have all of them an immunity from cholera, and that a true cholera process can not be artificially produced in them. Hence we must give up this method of proof.

Nevertheless one can not therefore say that no proof at all of the pathogenic action of the comma bacilli can be brought forward by this means. I have already explained to you that, as far as I am concerned, I can not, even excluding these experiments on animals, form any other opinion, except that there exists a casual connection between the comma bacilli and the cholera process. If later attempts to produce in animals something similar to cholera should be successful they would not be more convincing to me than the facts which stand now at our disposal. Moreover, we know other diseases which do not spread to animals, for instance, leprosy; and yet we must assume, from what we know of the leprosy bacillus, that it is the cause of leprosy. In this disease also we can not avail ourselves of experiments on animals, for up till now no species of animal has been found susceptible to leprosy. Apparently it is just the same with typhoid fever; I do not know that anybody has been successful in infecting animals with it. Hence we must be satisfied if we can establish the constant presence of a



certain kind of bacteria in the disease under consideration and the absence of the same bacteria in other diseases. The bacteria in question must always go hand-in-hand with the infective material of the disease, and what I especially lay stress upon, the occurrence of the pathogenic bacteria, must correspond to the pathological changes in the body and to the course of the disease. On the other hand, we are aware of diseases of the lower animals which can not be transferred to man, for example, rinderpest and pleuro-pneumonia. We here meet with one of the most widespread phenomena in nature. Almost all the parasites attack only one or a few species of animals which serve as its host. I would remind you of tape-worms; many species of animals have their own special tape-worm, which can develop only in that species and in no other.

We must, therefore, do without this part of the proof in a large number of infective diseases, including the exanthemata; and we can do this the more easily, because we are already acquainted with a whole series of other diseases which are caused by pathogenic organisms, in which, moreover, the conditions are similar, and with regard to which we know with complete certainty that the disease is produced by the organisms which are found in it, while on the other hand we have never yet seen that a disease produced a specific organism. I think that after we have learned to recognize a number of diseases produced by such parasites a deduction can be fairly made from analogy.

Besides we have at our disposal some observations quite as good as experiments on men. We can, in fact, regard as experiments what occurs under natural circumstances. The most important of these observations is the infection of persons having to do with cholera linen. I have had several opportunities of examining cholera linen, and have always found (as you could convince yourself in one of the microscopical preparations) the comma bacilli in enormous numbers, and almost as a pure cultivation in the mucus-like substance which is on the surface of the linen soiled with dejecta.

If then an infection occurs through the cholera linen, as the comma bacilli is the only organism in question, the infection can be caused by it only. Supposing the transfer has taken place thus: The washerwoman brings her hands, dirtied with the comma bacilli, in contact with her food, or directly with her mouth, or the water used for washing containing the comma bacilli is splashed about, and a few drops fall on the lips. In any case the conditions are exactly like an experiment in which a man has been fed with a minute quantity of a pure cultivation of comma bacilli. It is in fact an experiment which a man performs unwittingly upon himself, and it affords quite the same proof as if it were designedly done. This observation has been made so frequently and by such different medical men that there can be no doubt about it. Besides I can bring forward a similar observation made by himself. I have succeeded in finding the comma bacilli, with all their characteristic properties, in a tank supplying the drinking and service water to the entire surrounding population, and in the immediate neighborhood of which a number of fatal cholera cases had occurred. It was afterwards ascertained that the linen of the first of these fatal cases had been washed in the tank, and this is the only instance in which I have as yet been able to find the comma bacilli outside the human body. On the banks of this tank were situated 30 or 40 huts, in which dwelt from 200 to 300 persons. Of these, 17 died of cholera, though how many sick there were could not be exactly determined. A tank of this kind supplies drinking and service water to the neighboring inhabitants and receives all the refuse from the households as well. The Hindoos bathe daily in such a tank; they wash their apparel in it, and the personal excrement is placed by preference on its bank, and should a hut by any chance be provided with a lartine, it has its outflow to the tank. Just such a tank was the one in question. The little epidemic had already reached its height when the comma bacilli were found, at first in a fairly abundant amount and at several parts of the bank, but shortly afterwards, when only single cases were occurring, only at one place and in lesser amount. On the first discovery they were so abundant that their number could not have depended on the dejections and the washing water from the cholera linen thrown at one time or another into the tank. Some growth must have taken place. On the other hand, the small amount found at the second examination did not correspond to the numerous cases occurring

just previously. If these cases had furnished the bacilli in the tank water, then the bacilli would have been far more numerous on the second occasion than on the first. In this case, therefore, it can not be said that the presence of the comma bacilli in the tank was only a consequence of the cholera epidemic. On the contrary, the circumstances were such that the epidemic followed the bacilli. To these kinds of observations, and especially to infection through cholera linen, we must attach the greatest importance, for perhaps we may never be able to carry out direct infection experiments with any result.

For my view that the comma bacillus is the cause of cholera, I find further important evidence in the fact that the whole etiology of cholera, as far as it is known to us, is completely in accord with the characteristics of the comma bacilli.

We have seen that the comma bacilli grow extremely rapidly, that their vegetation quickly reaches a climax, then ceases, and that finally they are supplanted by other bacilli. This corresponds exactly to what goes on in the intestine in cholera.

It may be assumed that, as is the case with other bacteria, very few of the comma bacilli (under certain circumstances even one) might suffice to cause an infection. Correspondingly, we can well picture to ourselves single comma bacilli being admitted opportunely to the intestinal canal, and increasing there very rapidly. As soon as they have increased to a certain degree an irritation of the intestinal mucous membrane and diarrhea occurs; then as the increase goes on and reaches its height the peculiar group of symptoms, which we designate as the true cholera attack, appears.

We have formerly seen that it is highly probable that the comma bacilli can not pass the stomach under ordinary circumstances, at least in animals. This also agrees with all our experience of cholera, for it appears that predisposition plays an extremely important part in cholera infection. It may be presumed that of a number of individuals who are exposed to cholera infection only a fraction fall ill, and these are almost always those who had previously from some disturbance or other of the digestive organs, for instance catarrh of the stomach or intestine, or who had overloaded their stomach with indigestible food. Especially in the last case masses of food, more or less undigested and incompletely acted upon by the stomach, could pass into the intestine, and possibly could carry with them the comma bacilli not yet completely destroyed. Certainly the frequent observation is well known that most of the cholera cases happen on Monday or Tuesday, these being the days which succeed excesses in eating and drinking.

Now it is certainly a peculiar phenomenon that the comma bacilli should be confined to the intestine. They do not spread to the blood, nor even to the mesenteric glands. How does it happen, then, that this vegetation of bacteria in the intestine can cause death? To explain this it must be recollected that the bacteria in their growth do not only use up matter, but also produce substances of a very different kind. We already know a number of these products of bacteric fermentation, which are of a very peculiar nature. Many are volatile, and give off an intense odor, others form coloring matter, others again form poisonous substances. The decomposition of albuminous fluids, such as blood, produces poisons which, since the decomposition is only a consequence of the growth of bacteria, must be the products of change of these bacteria. Many appearances are in favor of these poisons being produced only by a given kind of bacteria, for we see that putrid fluids, which at one time can be injected into an animal without having any effect, at another time will prove to be highly poisonous. Thus I should explain the action of the comma bacilli in the intestine as being due to the poisonous products of decomposition. In support of this view I possess certain facts. In one of the cultivation experiments the gelatine had a fairly large number of blood corpuscles in it, as well as comma bacilli. After the gelatine had been poured out on a glass plate a number of colonies of comma bacilli grew. The plate had the appearance as if a red-colored dust was suspended in it, as the effect of the individual blood corpuscles could be clearly made out by transmitted light. In this red granular layer the colonies of the comma bacilli appeared even to the naked eye as small colorless bodies. When it was examined microscopically, it showed the surprising phenomenon that the colonies of the comma bacilli had destroyed all the blood corpuscles in



a fairly wide circle around them, which even extended far beyond the limit within which the gelatine had been liquified. Thus it appears that the comma bacilli can exercise a destructive influence on the formed elements of the blood and most probably on other cells as well.

Moreover, another observation has been made by an Indian physician, Dr. Richards, of Goolundo, which likewise is in favor of the existence of a poisonous material in the contents of the cholera intestine. Dr. Richards first fed dogs on a large quantity of cholera dejecta without producing any effect on the animals. He then performed the same experiment on pigs, which, according to his account, died of convulsions in a short time—fifteen minutes to two and a half hours after the meal. Here, then, was evidently an intoxication, and not, as Dr. Richards supposed, an artificial inoculation of cholera. The fact that this was the case was markedly shown by an experiment in which the contents of the intestine of a pig killed through feeding it on cholera dejecta, and having had the cholera according to Dr. Richards, was given as food to a second pig. The second animal remained healthy, and therefore there could not have taken place a reproduction of the supposed infective material in the intestine of the first pig. If a true cholera had really been produced in pigs then a second pig could have been infected with the intestinal contents of the first, and from this a third, and so on. If the experiment did not exactly prove what Dr. Richards intended, it is at least so far interesting as showing that under certain circumstances substances can exist in the cholera dejecta which are poisonous to pigs. Dogs appeared not to be affected by it, nor are mice and many other animals, as our experiments show. The power of resistance of other animals to this poison, and the susceptibility of the pig to it, should not cause surprise, if it is remembered that a poison, which is sometimes found in the salt meat and herring brine, also only appears to be fatal to pigs.

If it be accepted that the comma bacilli form a specific poison, the phenomena and course of cholera may be thus explained. The action of the poison shows itself, partly directly in the destruction of the epithelium, and, in the more severe cases, of the superficial layers of the mucous membrane, partly indirectly when it is absorbed, and acts on the entire organism, but especially on the circulating system, which is brought to a state of paralysis. The group of symptoms in a regular attack of cholera, usually thought to be the consequence of the loss of water and thickening of the blood, should be in reality considered, according to my idea, poisoning, for it not unfrequently happens, that even though a comparatively small quantity of fluid has been lost during life, through vomiting and diarrhea, the intestine also will be found to contain only a little fluid after death.

If death occurs in the stage of cholera poisoning, the post-mortem appearances correspond to those cases, in which the intestinal mucous membrane is very little changed, and the intestinal contents consist of a pure cultivation of the comma bacilli.

On the other hand, if this stage is prolonged, or if it is survived, then the consequences of the necrosis of the epithelium and mucous membrane make themselves evident. Capillary hemorrhage in the mucous membrane occurs, and the constituents of the blood mix more or less abundantly with the intestinal contents. Then the albuminous fluid in the intestine begins to decompose, and under the influence of the bacteria of decomposition other poisonous products are formed, which are likewise absorbed. These, however, act differently to the cholera poison, and give rise to symptoms corresponding to those commonly designated as cholera typhoid.

In accordance with the theory that the comma bacilli can grow and develop their action in the intestine only, the seat of the infective material must be sought for in the dejecta of the patient, and exceptionally in the vomit. I believe on this point I am in entire agreement with the more recent views. Certainly this theory is still contradicted by some investigators, but we possess such incontestable examples of it, especially infection by cholera linen, that, without regarding the cholera bacilli, there can be no doubt at all that the cholera dejecta really contain the infective material of cholera.

For the further spread of the infective material the main condition is, that the dejecta should remain in a moist state, for as soon as they dry up they lose their activity.

One of the most frequent paths by which the infective material spreads is water, of which we have had an example in the tank epidemic. How easily can cholera dejections, or water used for washing cholera linen, contaminate wells, public water courses, or other places from which drinking or service water is taken. From them the comma bacilli find many opportunities to return to their human habitation, either in the drinking water or in the water used for diluting milk, for cooking food, for scouring dishes, for cleaning vegetables or fruits, for washing, bathing, and so forth.

Besides, the infective material can reach the digestive organs by another way, for the comma bacilli can undoubtedly remain capable of life for a longer space of time in provisions which have a moist surface, and it can be easily imagined that they are not unfrequently propagated through the contact of dirty hands and such like. I also think it not at all improbable that the infective material is spread through food by means of insects, such as the common fly. In most cases certainly the infective material is deposited in the ground with the dejections, and finds a path some way or other into a reservoir or cistern.

I also go on the supposition that only moist substances (and they may be very different; I do not at all confine myself to drinking water) which in any way become contaminated by dejections can carry the infective material to the body. On the other hand, I do not believe that the infective material of cholera can retain its vitality in a dry state or, what is the same thing, that it can be transported by air, for the spread of an infective material by the air can, as a general rule, take place only when it is in a dry, dust-like condition. Also it is in accordance with experience that the infective material can not be spread in a dry state, for we know that up till now cholera has never reached us from India by merchandise; nor have letters and parcels sent by post ever brought cholera, even when they were not perforated and fumigated, as has happened frequently lately. Cholera has always, if we investigate more closely the origin of isolated epidemics, come to us in no other way than by mankind himself, and if in isolated epidemics we do not succeed in finding the individual who brought the cholera, we must not suppose that an exception has taken place, for we must remember that not only the individual who died of cholera, or who has had an undoubted cholera attack, is capable of spreading infection, but that there is every possible gradation between the most severe form of the disease and quite an unimportant diarrhea, which apparently is just as able to infect as the most severe case of cholera. However, absolute certainty will be obtained as to this important point only when the least severe cases come to be diagnosed as cholera cases by means of the comma bacilli.

There still remains a very important question to answer, namely, whether the infective material can reproduce itself and multiply outside the human body. I think that this is the case. As comma bacilli grow on a layer of gellatine, as they can grow on a piece of linen, in a meat infusion, or on a potato, so they ought to be able to grow outside the body, especially as we have seen that a comparatively low temperature makes their development possible. I certainly should not like to say that the increase of the comma bacilli outside the human body goes on directly in spring or river water, for these fluids do not possess that concentration of nourishment which is requisite for the growth of the bacilli; but I can easily imagine that, though the water in a reservoir as a whole is too poor in nourishment for the growth of the bacilli, certain places might have a sufficient concentration of nourishing material; for instance, where a gutter or the waste-pipe of a water-closet discharges into standing water, or when vegetable matter or animal evacuations, or the like, are deposited and are exposed to decomposition by bacteria. At such points an active life can be developed. Formerly I made many such investigations, and it has often happened to me that water contained almost no bacteria at all, while vegetable refuse (especially roots or fruits) which floated therein swarmed with bacteria, particularly of the bacillus and spirillar varieties. Even in the immediate neighborhood of such objects the water was rendered muddy by the crowds of bacteria, which evidently obtained the necessary nutriment from the material which, as the result of diffusion, surrounded it for a short distance.

I think that we can, then, very easily demonstrate the connection between the ground water and the spread of cholera. Everywhere where water stagnates on the surface, or in the



ground, in marshes, in docks which have no outlet, in places where the ground is formed like a trough, in sluggish rivers, and the like, the conditions which have been described can be found. There a concentrated nutrient solution can form in the neighborhood of animal and vegetable decaying matters most easily, and give the micro-organisms opportunity for growth. On the other hand, whenever the water has a swift current, or is in a constant state of change, both on the surface and in the ground, these conditions occur less easily, or sometimes not at all, for the continuous current prevents a localized concentration of nourishment in the fluid sufficient for the pathogenic bacteria. The connection between the sinking of the ground water and the increase of many infective diseases we might explain thus: That with the sinking of the ground water the current which exists in it becomes very much lessened; besides, the mass of water lying superficially at disposal will be considerably diminished, and therefore such a concentration as I have described as necessary for the growth of the bacteria will be produced much sooner.

If we grant that cholera depends on a well defined specific organism, then we could not admit a spontaneous (autochthonous) origin of cholera in any place. Such a specific organism, even if it is only a comma bacilli, follows just as much the laws of growth as a highly developed plant. It must always develop from its like, and can not be produced from other things or out of nothing. But since the comma bacilli do not belong to the universally distributed micro-organisms, we are compelled to trace the disease dependent on them to well-defined localities, from which these micro-organisms have been brought to us. We could not, therefore, imagine that the cholera can arise of itself, even though exceptionally, in the delta of the river Nile, because this is in some respects similar to the delta of the Ganges, as was last year asserted in all earnestness. Just as little can we think, that cholera could arise here among us in Europe without previous importation of the comma bacilli. An attempt was once made to prove that a cholera epidemic occurring in Europe, which had apparently broken out in an isolated manner in Poland, had arisen spontaneously, but later it became evident that this mode of origin could not be admitted, for the cholera in this case had existed in various parts of Russia in small unobserved epidemics, and had been carried to Poland by troops. A short time back a somewhat similar example came to my notice. About ten years ago the cholera broke out suddenly in the town of Hamah, in Sibiria, and nobody knew how it had come there. It was repeatedly declared that it had arisen spontaneously. I was lately asked about it by a French physician in France, and since there was nothing definite to be found on record as to the origin of this epidemic, I could only answer, that the mode of introduction in this case had not yet been made clear; but I gave as my conviction that the origin of the cholera in Syria must be traced back to India, while I pointed out at the same time that the epidemics in Syria and Egypt, apparently arising spontaneously, had occurred in the trade route between India and Europe, or in its immediate neighborhood, and that it had never risen in places which had no connection with India. Soon after this I was accidentally put into the position to get a satisfactory explanation of the origin of this epidemic. In Lyons Professor Lortet, who had been himself in Hamah during this epidemic, and had instituted inquiries as to the origin of the cholera, informed me that the cholera had been brought to Hamah from Jeddah by Turkish soldiers.

Undoubtedly, as far as we have gone, we are unacquainted with a cholera epidemic, which has arisen spontaneously outside India, and on this point experience agrees with the proposition, that cholera is dependent on a specific organism whose habitat is in India.

Now, the relative conditions of cholera in India are of quite a peculiar nature. I do not believe that the whole of India is the father of the comma bacilli. Formerly, indeed, it was asserted that cholera was at home in Ceylon, in Madras, in Bombay, and had subsequently spread over almost the whole of India, but this has been rightly denied. Only in regard to the Province of Bengal there exists no difference of opinion. All authors are agreed that the delta of the Ganges is the true home of cholera, and I have come to the conviction that this is the case, and that there are no other places of origin of cholera in India; for the only district in India, where cholera prevails continually year after year in a uniform manner, is the delta

of the Ganges. In all other places it shows marked variations, or it may even disappear altogether for a shorter or a longer time. In certain places—for example, in Bombay—it never entirely disappears, but it is highly probable that on account of the unusually active trade with the rest of India, it is constantly being imported there afresh.

Over the whole of this district, and on the banks of the Ganges as far up as Benares, cholera continually prevails. On closer examination of the map, it must strike one that the upper part of the delta is thickly covered with townships, while the base of the triangle appears quite uninhabited. This uninhabited stretch of land, called the Sunderbuns, embraces an area of 7,500 English square miles, and is separated from the densely inhabited northern part by quite a sharp line. Here the great rivers, the Ganges and the Brahmaputra, break up into a net-work of water courses, in which the sea water, mixing itself with the river water, flows hither and thither with the tide, and at flood time places large tracts of the Sunderbuns under water.

A luxuriant vegetation and an abundant animal life have developed in this uninhabited region, which is inaccessible to man, not only on account of the floods and the numerous tigers, but is avoided principally on account of the pernicious fever which attacks everybody who remains there even for quite a short time. One can easily imagine how dense the vegetable and animal matter is which is given up to decomposition in the marshy districts of the Sunderbuns, and that here an opportunity is afforded for the development of micro-organisms, such as exists in scarcely any other place on the globe. Peculiarly favorable for this are the regions between the inhabited and uninhabited parts of the delta, where the excrements of an unusually thickly populated country are washed away by the current, and flowing here and there, are mixed with the brackish water of the Sunderbuns, already teeming with decaying matter. Under these peculiar conditions quite a distinct fauna and flora of micro-organisms must be developed there, to which, in all probability, the cholera bacillus belongs, for everything points to the cholera having its origin in this district. All the greater epidemics have begun with an increase of cholera in the southern portion of Bengal. Jessore, from which the first intimation of the epidemic of 1817 came, lies on the borders of the Sunderbuns; and Calcutta, which is now the fixed home of the cholera, is connected with the neighboring Sunderbuns by a marshy and sparsely inhabited tract of land.

Now the comma bacillus finds in this district, contiguous to its presumptive home, the most favorable conditions imaginable to implant itself and to spread from one individual to another.

Lower Bengal is a perfectly flat country, which rises only slightly above the sea level and during the rainy season is under water to almost its entire extent. Everyone who builds there protects himself from these yearly floods by placing his house on elevated grounds. This form of building is seen in all the villages of the delta, even in Calcutta itself, though chiefly in its immediate neighborhood and in the suburbs, which bear more or less a village-like appearance. Each house or group of houses stands on a flat elevation which is formed by earth being taken from some spot lying near the site and piled on the building ground. The excavation thus formed becomes filled with water and forms the so-called tank.

Each house or group of houses must have, therefore, a more or less large tank, and their number is correspondingly very great. In the town of Calcutta there were a short time ago about 800 tanks, although many had already been shut up for sanitary reasons. In the suburbs of Calcutta there still exist more than 1,000. What part the tanks play in the household economy of the native population and how favorable they are for spreading cholera, I have already previously indicated.

It must be evident that an improvement in the state of the water in those districts will exercise a decided influence on the cholera situation. In truth all testimony shows this in Calcutta. This town, situated on the Hoogley River, has about 400,000 inhabitants and its suburbs have at least as many more. Until the year 1870, Calcutta, that is the main town, had yearly from 3,500 to 5,000 deaths from cholera and the suburbs had a corresponding proportion. Already in 1865 they had begun to drain the town, first in that part which is



inhabited by Europeans and which is most extensively built upon; later also the east of the town was gradually provided with a system of drains, but until the year 1874 there were not many houses in the native part of the town really connected. Only in some quarters was the network of channels completely built, as may be seen in the plan before you. Since then the completion of the drainage has been continually worked at and is now pretty far advanced.

I must mention at this point one peculiarity of Calcutta. In the central parts of the town, among massive houses and palace-like villas, there are groups of huts like villages, thickly crowded together, which are exclusively inhabited by the natives. These villages lying in the town are called Bustees. Closets, latrines, and the like, the huts of a Bustee do not possess. All the dirt collected between the dwellings can, on account of the closeness of the buildings, be only incompletely removed, and therefore is carried directly or washed by the rain to the tanks, the natural cesspool for all the fluid filth. Connection between such huts and this system of drainage is out of the question.

At the same time with the drainage the construction of water-works for Calcutta was taken in hand. Water was taken from the Hoogley several miles above Calcutta, was well filtered, and then conducted to the town. The water-works were opened in the year 1870.

From 1865 to 1870 the effect of the gradually extending drainage on the cholera mortality was not noticed. But immediately after the opening of the water-works the cholera diminished, and since that time has remained on an average at about a third the previous amount. The drainage has also considerably advanced toward completion since 1870, but, as it has not yet further increased the remission of cholera which had suddenly begun with the entrance of good drinking water, the favorable effect in this case can only be ascribed to the water-works. If, in spite of this, cholera still continues relatively frequent in Calcutta, it is due to the fact that a great part of the population take what water they need, not from the water conduits, but in the old-fashioned way from the Hoogley, or from the numerous tanks.

In the suburbs, which stand in direct connection, and the closest intercourse with the town, but which do not participate in the water supply, the cholera mortality remains as before.

Still clearer does the influence of the water arrangements show itself in Fort William, which stands in the middle of the town on the Hoogley. The fort itself is not drained, and because of the distance from the nearest town drains can not be included in the system of drainage. The relations of the ground water must be exactly the same as they were at the time of the construction of the fort. Formerly the garrison of the fort was every year severely visited by cholera. But since the beginning of 1860 the attention of the officials was drawn to the drinking water, which was guarded as far as possible from impurities, and since then the cholera has markedly declined. The fort received an absolutely reliable water at the same time as the town, and from that time forth cholera has disappeared from the fort. This case may be regarded as a regular experiment, in which all the conditions have remained unaltered except that of the drinking water. If the cholera does not visit the fort any more, it can only be ascribed to the change in the drinking water.

There are similar if not so striking examples of the influence of drinking water on cholera in other Indian towns. It is so in Madras, where cholera has declined to a marked extent since a water supply was introduced; similarly in Bombay. But particularly interesting in reference to this is what has occurred in Pondicherry. Formerly cholera occurred very frequently in this town. For a number of years artesian wells of a depth of 300 or 400 meters have been in use, and from that time cholera has disappeared from Pondicherry. Last spring, nevertheless, it was unexpectedly announced that the immunity of Pondicherry, already assumed to be certain, had proved by no means to be relied upon. In consequence I communicated with Dr. Furnell, of Madras, who had occupied himself mainly with the behavior of cholera in Pondicherry, and obtained from him the intelligence that it was a fact that a number of cases of cholera had occurred there, but exclusively in those portions of the town which had not yet been provided with artesian wells.

Though I have cited to you some examples of the advantages of a good supply of drinking water, the assurance that I am not a supporter of the exclusive drinking-water theory is scarcely necessary after my former deductions. I want specially to avoid any prominent point of view, for I consider that the ways in which cholera can spread itself are extremely different, and that almost every place has its own peculiarities which have to be thoroughly investigated, and the regulations which are to serve for the prevention of infection in the place in question must be drawn up accordingly.

Moreover, in India the spread of cholera depends on human intercourse, and this is principally due to the very unusual extent to which pilgrimages are developed there. We can scarcely imagine to what a degree pilgrimages are carried in India. To give you an example I shall only mention the two principal places of resort for pilgrims, Hurdwar and Puri. These are places in which every year hundreds of thousands, often over a million, of men congregate together from all parts of India. The pilgrims remain there for several weeks; they are packed together in the narrowest space, and live in the most miserable condition. In these places also tanks are everywhere found, in which thousands of men bathe and out of which they drink. These are circumstances which do not make it appear at all wonderful that this disease, when it develops among the crowds of pilgrims, quickly spreads out over the whole of India.

Cholera originally traveled beyond the boundaries of India, through north India to the interior of Asia, from there to Persia, and thence to the south of Europe. But this has become altered, since commerce does not go any more by the caravan route through Persia, but by sea through the Red Sea and the Suez Canal. I scarcely think that an invasion of cholera by the land route through Asia is now to be feared. It is not absolutely impossible that it may take this route, but it is not probable. But, on the other hand, the other way, the sea route from India through the Red Sea, principally from the chief harbor of export, Bombay, will become, in my opinion, from year to year more dangerous. From Bombay, which is seldom free from cholera, Egypt can be reached in 11 days, Italy in 16 days, and the south of France in 18 or, at the most, 20 days.

These spaces of time, in comparison to what was the case formerly, have become so extraordinarily short that the dangers of the direct importation of cholera from India to Europe will become continually greater. As in reference to this the manner in which cholera behaves on board ship is of special interest, I should like to have permission to make a remark about it.

It has always surprised me that true cholera epidemics only occur in ships which have on board a large number of men, while on ships manned to a less extent, and on all merchant ships, cholera epidemics lasting for more than a week never arise, even if cholera cases occur on the first day of the voyage. Because this point is of the greatest importance not only for the etiology of cholera, but also for maritime trade, I have made inquiries about it as far as possible, and have found that this observation is completely confirmed.

If the question which arises from ship cholera is discussed, we must cast our eye on ships which serve as transports for masses of men, such as troop ships, pilgrim, coolie, or emigrant ships. On those which start from cholera-infected ports, cholera does not occur so seldom as is frequently supposed. The attempt has sometimes been made to show that marine traffic is as regards the spread of cholera, quite without danger, for it is calculated that to such and such a number of ships free from cholera, there is only one on which cholera breaks out. To this calculation must be opposed the fact that, even if out of a thousand ships only one has cholera on board, it stands to reason that this one cholera ship can do just as much mischief as if all the thousand had been infected. If the calculation of the proportion between ships free from and those infected by cholera be limited to the crowded transports, the results, as I have said, is much less favorable than people imagine.

In the reports of the sanitary commissioner with the Government of India for the year 1881, there is found a highly interesting table of cholera on the coolie ships which sailed from Calcutta. These ships are not very large, though they carry from 300 to 600 Indian laborers, so-called coolies, mostly to the British colonies in America. Of such ships, 222 made the voyage during 10 years; of these, 33 had cholera, and in 16 of them the epidemic lasted more than 20



days. One can thus easily imagine how great the danger of a cholera invasion must be to the more nearly situated parts of Europe, if a similar coolie transport should go to Egypt, for instance, or to any of the Mediterranean ports.

There is one question in the etiology of cholera which is rather of a theoretical interest, and on which I have not yet had the opportunity of expressing my opinion, and which, therefore, I shall only shortly touch upon. This question is the explanation of the noteworthy fact that cholera, outside of India, disappears after a relatively short space of time.

The extinction of the infection appears to me to depend on different factors.

First, I consider it settled that, as in many other infective diseases, an individual obtains a certain immunity by a previous attack of cholera. This immunity does not appear to last very long, for there are instances enough of people, who had been attacked during one epidemic, falling ill of cholera a second time during another; but one has seldom heard of anybody being attacked twice in the same cholera epidemic. Repeated attacks of cholera, however, ought to occur often, for the individual who has recovered from an attack of cholera usually returns again after some days to the same surroundings, and will be continually exposed to the same hurtful influences, and to the same source of infection. Further, some observations, which have been made in India, indicate that a certain immunity is obtained after an attack of cholera. Now, as a single individual can obtain an immunity, so can a whole district become more or less safe for a certain space of time, as many instances teach us. It is often seen that if the cholera attacks a place, and infects it through and through, and afterwards appears again in the next year, this place is almost entirely spared, or is only very slightly attacked.

As a second reason for the extinction of a cholera epidemic, the absence of a resting stage of the cholera bacilli is of importance, for with its help the infective material could outlast the duration of the immunity of the inhabitants, which would be an unfavorable time for its further progress.

Finally, there is still to be considered the circumstances that temperatures which are under seventeen degrees act so unfavorably on the growth of the bacilli outside the body that an increase no longer takes place. If all these factors work together—if, therefore, winter comes and there is only left a population more or less immune to cholera—then, since there exists no resting stage in the infective material, the epidemic must become extinct.

Before I finish I should like to say a few words on the practical use we can put the discovery of the comma bacilli to. It is commonly said, What is the use of such a discovery? We certainly know that cholera rises from bacilli, but in spite of this we can not cure the disease any better than formerly. I remember that similar opinions were frequently expressed with regard to the discovery of the tubercle-bacillus. He who looks at these things exclusively from the point of view of the prescription-writing physician, is certainly right, for he has still no palpable application before his eyes, but yet these critics ought to remember that a rational treatment for the majority of diseases, and especially for infective diseases, can not be carried out until their cause and nature has been recognized. I have hopes that even without this the discovery of the cholera bacilli will be of very great use. First, I think it may be of use from a diagnostic point of view. It is extremely important that the first case, which occurs in any country or place, should be correctly diagnosed. In my opinion one can now determine with certainty whether cholera is present or not by the demonstration of the cholera bacilli. This appears to me to be a very important advantage.

Further, I believe that after we have recognized the true cause of the disease and its peculiarities the etiology of cholera can be constructed on definite and established lines, and something final can be formulated out of its many contradictions. Now we shall obtain an established basis for an harmonious course of action, the scope of which will be definitely known. I hope to get especial advantage from the observation that the comma bacilli are destroyed by drying; certainly the fact that the choleraic infective material is destroyed by drying should have been made use of in practice earlier than now, but it wanted experimental support, and there was never any certainty about it. Now we can put down the peculiarities of the infective material as quite decided facts, and can reckon on them in the future; but

the greatest advantage we obtain from it is, that a limit is once and for all put to the frightful waste of disinfectants, and that millions of money will not be again poured into the gutters and water-closets, as in the last epidemic, without being of the smallest benefit.

Moreover, I lean to the hope that, therapeutically, recognition of the comma bacilli will be of use. In the future a diagnosis can be made in the milder cases, and at the commencement of the disease. Therapeutic attempts will become correspondingly more certain if it is known that the patient really suffers from cholera. An early diagnosis must be indeed of the greatest value, for the prospects of a therapeutical result are brightest at the commencement of the disease.

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REPORT OF RESEARCHES UPON THE CHOLERA IN EGYPT.

BY STRAUS, ROUX, THUILLIER AND NOCARD.\*

We have the honor to present to the Biological Society a summary report of our study of cholera in Egypt, with the histological preparations relating thereto.

When we arrived in Egypt on the 15th of August, 1883, the mortality at Alexandria reached its maximum (40 to 50 deaths per day). Dr. Ardouin, chief physician of the European Hospital, placed himself at our service. We also received the valuable assistance of Dr Sierra, an attaché of the same hospital.

The autopsies which we performed numbered 24. Of this number there were 7 males and 17 females, of whom 5 were pregnant or recently delivered; the youngest was five years of age, the oldest fifty-four; the majority of the autopsies were upon individuals aged twenty to thirty, five years. Fifteen of these cases developed rapidly, death supervening in ten hours to three days after the commencement of the attack; nine autopsies were of prolonged cases (four to fifteen days) with or without typhoid reaction. The subjects were of various nationalities residing in Egypt, Italians, Maltese, Greeks, Austrians, and Syrians. We were not able to perform an autopsy upon any native.

A favorable circumstance for these investigations which we were unable to obtain in Europe is the fact that we were subject to no delay in opening the body. In a certain number of the cases we were able to perform the autopsy *immediately* after death, and the latest *post-mortem* examination was not longer than fourteen hours after death. It is easily understood what advantages were thus obtained, as well from the point of view of search for pathogenic micro-organisms as from the point of view of anatomo-pathological studies. Every complication due to putrefaction was thus avoided, and the lesions which were observed could be considered as belonging exclusively to the disease.

We shall not dwell upon the well-known anatomical lesions (dryness of muscles, fluctuating intestines, absence of gas, viscous coating of the peritoneum, and of other serious membranes, distension of the large venous trunks, etc). Abundance of the cerebro-spinal fluid was always observed in sharp contrast with the general dryness of the body.

The symptoms and anatomical lesions of cholera are such that one is naturally led to first search in the intestines for the microbe as the cause of the disease. The microscopic examination of the characteristic stools of cholera patients or of the intestinal contents obtained from the cadaver revealed the presence of a very large number of organisms. These were of diverse varieties; bacteria of varying size, some motionless, others mobile, isolated micrococci, united in zooecia masses or disposed in chains. *Having to do with such a great variety of organisms, it was obviously impossible to distinguish and to designate those which, more than any other, might be the cause of cholera.* The examination of the vomited material and of the contents of the stomach revealed the same diversity of microbe.

The rice-like flakes contained in the stools consisted in great part of desquamated epithelial cells, some still adhering together and forming a mold of the villi, others isolated and in process of granular degeneration. The nucleus of the most of these cells had lost its faculty of coloring by carmine and aniline dyes (coagulation necrosis).

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\* Compt. ren. de la soc. de biologie, 1883.



Sections were made from diverse portions of the digestive tract and were examined for the presence of micro-organisms in the depth of the intestinal walls.

The reagent employed by preference and which gave the best results was a weak aqueous solution of methyl-blue (2 cubic centimeters of concentrated alcoholic solution of methyl-blue in 140 grams of distilled water). The sections were placed therein for 10 to 24 hours, dehydrated by alcohol, cleared by oil of cloves, and mounted in Canada balsam.

In preparations thus treated one demonstrates at first the almost complete disappearance of the epithelial covering, partly as a result of the disease and partly as the effect of the hardening fluid employed (alcohol). The epithelial covering of the body and of the fundus of the glands of Lieberkuhn, the ducts of the tubular glands, the connective tissue framework of the villi, the intertubular connective tissue and in places the submucous tissue contained diverse micro-organisms in variable numbers according to the portion of the intestine examined and the duration of the disease. The most numerous of the micro-organisms are bacilli of variable size and form; some are long and narrow, others short and of a greater diameter. One of the most frequent forms is a thin bacillus about two millimeters long, quite closely recalling the appearance of the bacillus tuberculosis. At certain points this variety of bacilli predominates, manifestly forming nests or elongated clumps which invade as far as the submucous tissue without ever penetrating the blood vessels or the muscular tunic.

This is without doubt the bacillus which Koch describes in his report, which appeared the 13th of October, 1883, in the North German Gazette, and which he compares on account of its appearance to the bacillus of glanders. He is moreover evidently inclined to consider it as the characteristic organism of cholera.

Furthermore, there existed other forms of bacilli of still smaller dimensions, and here and there there were numerous micrococci infiltrating in the mucous membrane or the villi. This enteromycosis is especially marked in the lower portion of the small intestine; in certain cases it exists, although to a slighter degree, in the jejunum.

What significance must one attribute to this anatomical picture? In view of the rapidity of the autopsy, the idea of a cadaveric process must be excluded; but during life a mucous membrane despoiled of its epithelium, like that of the intestine in cholera, must be easily invaded by the micro-organisms contained in the fluid which bathes it.

The variety of microbes which one observes in the preparations should awaken in the highest degree the suspicion of a *secondary* invasion of the intestine. If a relation of cause and effect really exists between one species of these microbes found in the intestinal walls and cholera it should be met with in *all* autopsies of cholera patients. Now, we have observed the presence in the intestinal mucous membrane of these micro-organisms, and especially of bacilli resembling that of tuberculosis, particularly in the cases of cholera which are prolonged and which are accompanied by hemorrhage of the intestine. But in three of the *foudroyante* cases, where the subjects had succumbed in 10 to 20 hours, and where the intestine was rather anæmic than congested, it was impossible for us by the examination of numerous sections and careful search to demonstrate its presence. Now, it is precisely in these foudroyante cases that the presence of a microbe in the intestinal mucus, if it were really pathogenic and characteristic, ought to be revealed with the greatest certainty.

The mesenteric ganglia, the liver, the spleen, the kidneys, have furnished only negative results concerning the presence of micro-organisms.

The blood of cholera patients is black and presents in the highest degree the characteristics of an asphyxiated and infected blood. Collected with a sterilized pipette, the globules rapidly sink to the bottom and are covered by a layer of clear serum, which may remain a long time without coagulating. At other times after a variable time the blood forms a clot which contracts or remains diffuent.

Under microscopic examination, the red globules spread out upon the object-slide and seemed pale and *poisseux* without always adhering together as in charbon. The white globules are increased in number and filled with brilliant granules.

In the blood of patients dying in twenty-four hours, which we observed, we saw in the free species comprised between the globules, small, very pale bodies, slightly elongated,

appearing to be contracted in their middle, comparable to the microbes of lactic ferment, but much smaller, and of a refraction so feeble that they are very difficult to see. The blood of the heart at times contains them in abundance, but in general the blood of the mesenteric gastric, portal, and subhepatic veins is most abundant in them. They absorb badly the aniline colors, and thus there is great difficulty in obtaining demonstrative stained preparations, all the more so since one is always afraid of confounding so small an organism with deposits of coloring matter or granules of protoplasm.

If one places in the oven at 38° C. for 24 to 48 hours, tubes of pure choleraic blood, one sees that these bodies are increased in number, and at times are united in two or four forming small chains. It seems that under these conditions there may have been a culture of a micro-organism in the blood.

In the majority of cases the blood-serum preserved in tubes becomes slightly but appreciably acid; in one case where the pericardial fluid and the blood had been examined immediately after death, the same observation was made.

In order to furnish the proof that in this body we have really to do with a micro-organism, it is necessary to successfully obtain a culture in appropriate fluids. We have not succeeded in doing this, notwithstanding the employment of the most varied culture media (neutral chicken-bouillon, veal-bouillon, albumen-bouillon, neutral urine, milk, blood-serum of beef, blood-serum of rabbit.

Neither did we succeed in our numerous attempts to produce cholera in animals. Chickens, pigeons, cailles, a dinde, geais, rabbits, guinea-pigs, rats, mice, dogs, cats, a monkey, and pigs have been vainly fed at divers times upon rice-like stools and vomited matter, fresh or dried, or upon quantities—frequently considerable—of intestines, viscera, and blood of cholera patients. The same negative results for the intravenous and subcutaneous injection of cholera blood were obtained.

From these experiences we have not the right to affirm that the animals are unsusceptible to cholera, but that the mode of inoculation and the conditions of virulence which would permit the transmission of cholera to these animals are still to be discovered.

Such are, very briefly, the principal facts that we have collected during these two months of study. They are far from furnishing the solution of the etiological problem of cholera, but perhaps they may not be useless for the understanding of future researches.

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#### RESEARCHES UPON THE MICROBE OF ASIATIC CHOLERA.

By E. VAN ERMENGEM.\*

The author, in the course of an exhaustive report of his investigations concerning Asiatic cholera, as special commissioner appointed by the Belgian Government incorporates the following conclusions:

(1) There exists in the intestinal contents of patients attacked with cholera (8 autopsies and 34 cases in which the examination of the stools was made) a micro-organism identical with the comma bacillus discovered by Koch.

(2) Its curved form, its grouping in S-figured outline and in chains, formed by the juxtaposition end to end of separate commas, and sometimes its appearance in the form of slightly undulating filaments, furnish a group of microscopic characters which usually allow it to be easily distinguished from the pathogenic micro-organisms up to the present known.

(3) It is more or less abundant in the intestinal contents, according to the period of the disease and that at which the examination is made. In two foudroyant cases it existed in the intestinal contents as almost a pure culture. In a case of short duration, where the patient had died with very pronounced symptoms of algidity, the commas were found to be very rare in the intestinal fluid. They disappear in the colored stools of the period of reaction.

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\* Official report presented to the Minister of the Interior of Belgium, 1885.



(4) It would have been very important to have sought for these organisms in the dejecta of patients attacked with the so-called premonitory diarrhea, but my investigations did not cover this point.

(5) In the single case of algid cholera in which microscopic examination did not show numerous commas, a minute quantity of the intestinal material spread upon soiled linen and placed in a moist chamber gave, after 24 hours, an incalculable number of characteristic comma bacilli.

(6) Microscopic examination of dejecta could suffice for the establishment of the diagnosis of asiatic cholera if preparations are obtained in which the divers forms of comma bacilli predominate.

(7) Bacteriological researches supplemented the insufficiency of the microscopical examination in cases where the comma bacilla were rare, or were not to be found with certainty in preparations. The characteristic aspect of their colonies, seen under a low magnifying power (120 diameters), enabled one to recognize them with certainty.

The practical value of culture upon the object-slide and in nutritive gelatine of 10 per cent. is well demonstrated by my experiments. Mixtures of a very small quantity of a culture, with quite considerable quantity of putrefied blood, urine exposed to air, fœcal matter, hay-infusion, etc., furnished preparations in which the typical colonies of the comma bacilli could be distinguished with facility in the midst of the most varied growths.

(8) The study of the morphological characters of the comma bacilli at various periods of developments, and cultivated in various media, but principally in chicken bouillon and fluid serum, shows that they should be regarded as closely allied to the true spirilli.

(9) The most adverse conditions of temperature and of medium have not enabled me to recognize the existence of a period of sporulation. The want of resistance to desiccation very well proves that they do not form resistant spores.

(10) Cultures in gelatine cease to be transferable six or seven weeks after having been inoculated. Cultures upon agar-agar still contain living organisms after eight to nine weeks.

(11) The most favorable temperature for their development appears to be that of 25° to 37° C. Below 16° C. (between 8° and 15° C.) they still develop, but feebly.

(12) Their phenomena of growth and multiplication are extremely active. In two or three days they liquefy completely several cubic centimeters of coagulated serum.

(13) The curved bacilli of the saliva, already described by Miller (March, 1884), and which Dr. Lewis believes to be identical with the comma bacilli of cholera, do not develop in 10 per cent. gelatine.

(14) Cultures of the organism to which Finkler and Prior attribute the production of cholera nostras are impure (the one which I have examined contains two species of bacilli); their mode of vegetation and the appearance of their colonies in gelatine differ from those of the comma bacilli of Asiatic cholera. One of them communicates to the culture media a greenish-blue, very characteristic fluorescence, which is absent in pure cultures of the comma bacilli.

(15) The attempts at inoculation with products of culture have given, up to the present time, very encouraging results in some species of animals, such as dogs, rabbits, and Guinea-pigs. Three Guinea-pigs out of four have died in two or three days after the injection into the duodenum of a drop of a culture (fourth day) of comma bacilli in liquid serum, after the method of Nicati and Rietsch, of Marseilles. The *post-mortem* phenomena were those of cholera, and the intestinal contents contained large numbers of the comma bacilli.

(16) The pathogenic action of these products of culture is probably due to zymese, an albuminoid substance, easily destructible. The globules of fresh human blood placed in preparations upon the warm stage of Ranvier and brought into exact contact with a drop of a culture serum, presents characteristic alterations quite comparable with those described by Nicati and Rietsch after their observations upon cholera blood.

(17) The discovery of the comma bacillus has the greatest importance for the diagnosis of choleriform cases of a doubtful nature which occur at the commencement of an epidemic, and for the prompt application of efficient prophylactic measures.

(18) The application of bacteriological methods to the diagnosis of true cholera does not offer great practical difficulties, and it would be extremely desirable, in view of the serious danger of the invasion of Belgium by cholera, that a sufficient number of physicians connected with the sanitary services should be initiated in these methods without delay.

(19) The knowledge of the biological properties of the cholera microbe and of its feeble resistance to desiccation, and of the absence in its evolution of a period of spirulation furnish data for prophylaxis. It places a limit to the excessive application of means of disinfection, and places us in possession of more simple and surer methods for combating the effects of these germs.

According to Van Ermengem (*Recherches sur le microbe du cholera asiatique*, Paris and Brussels, 1885), curved bacilli are found in the intestinal canal of healthy Guinea-pigs, but under culture they differ from the comma bacillus of Koch. Control experiments, such as the injection of various decomposed products into duodenum of Guinea-pigs, etc., where almost all is harmless. This author confirmed Koch in the most important particulars, as well as substantiated the results of the inoculation experiments of Nicati and Rietsch. There is one important particular, however, concerning the morphology of the comma bacillus of Koch which this author mentions. He describes the presence of bullet-shaped swellings in the course of cholera spirilli which in Koch's first detailed publication find no mention. Concerning the significance of these bullet-shaped bodies, which he regards as identical with Ferrán's so-called antheridia, this author speaks very guardedly, holding it however not impossible that they represent a sort of permanent state of cholera bacilli. In a later publication, appearing near the same time as the communication of Hüppe, concerning the morphology of the comma bacillus of Koch, whose preparations Van Ermengem saw, this latter author speaks more positively of these globular masses, asserting that they are very probably reproductive, corresponding with arthrospores. Respecting the antheridia-like bodies which he had already seen before Ferrán, Van Ermengem could not satisfy himself, in spite of numerous careful examinations relating to Ferrán's view of the development of the comma bacilli.

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#### NEW INVESTIGATIONS CONCERNING THE CHOLERA MICROBES.

By DR. E. VAN ERMENGEM, *Professor of Hygiene and Bacteriology in the University of Ghent.\**

The author announces the results of his exhaustive study, which is an important additional contribution to the knowledge of cholera in the following conclusions:

(1) There is in the intestinal contents of cholera patients an organism which is identical with that discovered by Koch, and named the comma bacillus.

(2) Its curved form, its grouping in S-shaped outlines and in chains, and its appearance in the shape of curved threads, give a sum-total of microscopical characters which allow it to be distinguished from all other now known pathogenic micro-organisms.

(3) The bacillus shows its appearance in the evacuations and in the vomit of cholera patients in greater or less numbers according to the period of the disease at which the observation is made. In two acute cases it was found in the intestinal contents as almost a pure culture. In one fatal case, where the patient died in the algid stage, very few bacilli were found in the fluid contents of the intestines. The bacilli disappear in the colored stools of the reaction period.

(4) In a single case of algid cholera, where the microscopic investigation showed only a few bacilli, twenty-four hours after the placing of a small quantity of this fluid upon moist linen a large number of characteristic comma bacilli could be seen.

(5) The microscopic examination of infectious material is sufficient for the diagnosis of Asiatic cholera, if one obtains preparations in which the different forms of the comma bacilli appear.

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\*Wiener Medizinische Presse, July 18, 1886.



(6) The bacteriological investigation removes the uncertainty of the microscopical method in those cases where the bacilli are few and there is difficulty in recognizing them. The characteristic appearance of their colonies permits a recognition of them under low powers. The practical value of cover-glass cultures, and of those in 10 per cent. nutrient gelatine, is demonstrated by these studies. Mixing a very small quantity of culture with a very considerable mass of decomposed blood, fermented urine, fecal matter, etc., furnishes preparations in which the typical colonies of comma bacilli can be readily recognized in the midst of those of the most various organisms.

(7) The investigation of the morphology of bacilli cultivated in different nutrient material, especially in chicken broth and in fluid serum, shows by its different stages of growth that this organism is very similar to genuine spirilli.

(8) Up to the present time various methods of culture at various temperatures have not brought to light a stage of spore formation. Their low power of resistance to the effect of drying shows indeed that they do not possess resistant spores.

(9) Cultures in nutrient gelatine, after 6 or 7 weeks, can no longer be cultivated. Cultures in agar still contain living organisms after 8 or 9 weeks.

(10) The most favorable temperature for the development of this organism appears to be from 25° to 37° C. At a temperature of from 8° to 15° C., growth is extremely slow.

(11) The appearances under growth and multiplication are most striking. In 2 to 3 days it renders fluid several cubic centimeters of coagulated serum.

(12) The curved bacillus of saliva, described by Miller (Mar., 1884), and which Dr. Lewis believed to be identical with the cholera bacillus, does not grow in 10 per cent. gelatine.

(13) The cultures of the organism which Finkler and Prior declare to be the cause of cholera nostras are impure. These cultures contain two varieties of bacilli; the manner of their development and the appearance of their colonies in gelatine differentiates them perfectly from comma bacilli; one of these organisms produces in the culture material a very characteristic bluish-green fluorescence, which is absent entirely in pure cultures of the comma bacilli.

(14) The inoculation experiments with culture products has furnished, up to the present time, in several species of animals, as dogs, Guinea-pigs, and rabbits, very interesting results. Three Guinea-pigs out of four died in 2 to 3 days after an injection into the duodenum of a drop of a 4-days' old bacillus culture in fluid serum, after the method of Nicati and Rietsch. The intestinal contents showed large numbers of comma bacilli.

(15) The pathogenic quality of the culture product is probably of an albuminous composition, easily broken up. Blood corpuscles observed in glass-slide preparations, to which one has added a drop of culture in serum, show characteristic alterations which correspond with the results described by Nicati and Rietsch.

(16) The discovery of the comma bacilli possesses the greatest value for the diagnosis of cholera cases of a doubtful nature, which always show themselves at the commencement of an epidemic, and for the application of combative measures which are rendered possible after a correct diagnosis. The application of bacteriological investigations for diagnosis is very easily followed in practice.

(17) The knowledge of the biological characteristics of the cholera microbe and of its low power of resistance against drying, furnishes a most valuable suggestion for prophylaxis. It places a limit to extensive and unnecessary disinfection, and places in our hands the simplest and safest means for limiting the danger.

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#### EXPERIMENTS WITH THE COMMA BACILLUS OF KOCH.

By VICENZI.\*

Vicenzi communicated the results which he had obtained by experiments upon animals in Schmidt's Chemical Laboratory at Wiesbaden :

(1) Intra-peritoneal injection of the comma bacilli was without result.

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\* Deut. Med. Zeit. 11, 28, 1887.

(2) The bacilli injected into the peritoneal cavity did not pass into the intestinal canal.

(3) They were absorbed by the lymph vessels, and entered the blood current and were therein destroyed.

(4) Different degrees and kinds of mechanical irritation of the small intestine rendered possible the transition of the comma bacilli into the intestinal canal, their multiplication there, and the development of their pathological qualities, whether they were injected into the abdominal cavity, directly into the blood, or under the skin and into the lungs.

(5) It is demonstrated that the small intestine is the favorite locus of the comma bacillus because it finds only there the favorite circumstances for its multiplication and for the development of its pathogenic qualities.

(6) The entrance of the bacilli into the glands of the mucous membrane of the intestine does not generally take place.

(7) In the majority of cases the comma bacillus, if in association with other bacteria, especially those of decomposition, shows an exuberant development in sterilized bouillon, and covers the free surface of the fluid only after a few days.

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#### AN INQUIRY INTO THE ETIOLOGY OF ASIATIC CHOLERA.

By E. KLEIN and HENNEAGE GIBBES.\*

The nature and origin of cholera have until recently been subjects about which a great many speculations and theories have been forwarded, in all of which the fundamental fact, viz, the demonstration and actual isolation of the cholera virus, was absolutely wanted.

The large number of observations made concerning the spread of cholera in India and the different visitations of cholera of Great Britain, the continent of Europe, and the Mediterranean has yielded a number of facts, which have brought the different observers, as it were, under three well-defined flags:

(1) According to some, cholera in its causation depends on no definite "entity," but is due to certain atmospheric and teluric conditions. Where these conditions prevail, as in Bengal, or where by some unknown change they obtain, as in the epidemics in Europe, cases of cholera occur. These cases stand in no casual relation to one another, but occur, like ague or intermittent fever, independently of one another, but are dependent on a common cause of soil and atmospheric state. This theory, then, does not admit cholera into the rank of the infectious diseases, and it is hardly necessary to say that in Europe this theory has no great number of followers, since, with few exceptions, almost all medical authorities are opposed to it.

(2) Other authorities maintain that, in the history of all the visitations by cholera of Europe and the Mediterranean countries, the character and course of every epidemic point clearly and unmistakably to the fact that cholera is dependent in a great measure on human intercourse, that each epidemic has had its origin in importation from a country where cholera cases had previously occurred, and that when once imported it is liable to and generally does spread to larger and larger areas; that if the first cases are isolated and sanitary precautions are taken the plague remains limited. This theory further says that cholera, being communicable, belongs to the group of infectious diseases, *i. e.*, diseases in which a virus, having had access to the body of a person, therein multiplies to an enormous extent, and thereby causes the disease; that the morbid products in the case of cholera—the vomits and evacuations—are charged with this new brood of virus, and that the smallest quantity of this is capable to start the malady in a new individual.

The upholders of this theory, viz, that cholera is a communicable disease, group themselves again into two distinct classes, (*a*) those that maintain that cholera is a contagious disease, *i. e.*, directly communicable from person to person, and (*b*) those that do not admit of direct

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\*Official report to the British Government, 1884.



contagion, but say that the substances voided by a patient in the vomits and evacuations are harmless while fresh and do not as yet contain the actual virus, but acquire this power only after they have undergone certain changes, these changes being dependent in a certain measure on the medium into which the cholera dejecta pass, not every medium being suitable for producing this change; having undergone this change, this substance assumes the character of the cholera virus; *i. e.*, finding access to the human body, either through the air we breathe, or food, or water, produces cholera.

(3) There is a third group of observers, headed by v. Pettenkofer, who, as is well known, is justly considered to be the greatest living authority on cholera. v. Pettenkofer is a localist, with this distinction, that, judging from his earliest and latest writings, he does not admit of the evacuations of a cholera patient containing the virus at all either potentially or actually, but considers the virus a product of an organism altogether extraneous to the body of a patient. This product is a kind of ferment, created by that organism only under certain favorable, seasonal, and local conditions.

The upholders of the first subsection of Group 2 are spoken of as the contagionists, those of the second subsection and of the Group 3 as the localists.

There is no doubt that, as regards the observations on the spread of cholera and on the nature of epidemics, an immense amount of valuable work has accumulated in India and Europe: Very capable and accurate observers have exerted themselves in this respect, and if the problem has not been solved as yet, it is doubtful whether any new observations in this particular aspect of the question will ever bring it to a solution. If it could be demonstrated with the same accuracy and to the same degree as has been done for some of the infectious diseases—notably splenic fever, tuberculosis, glanders, swine fever, erysipelas, etc.—that the virus is a living entity, capable of multiplication within the infected body and thereby causing the disease; that the products of the disease are charged with the same living entities; that these organisms are capable of starting the malady when introduced into a new individual, then the whole problem might be said to be practically solved.

To have achieved this demonstration is claimed by Mr. Robert Koch, sent out in 1883 by the German Government to investigate the outbreak of cholera in Egypt and to study cholera in Calcutta. Koch has published in full his observations and conclusions in the "Berliner Klin Woch," 1884, No. 31. In the periodical reports sent to his Government from Egypt and India, and still more in the above publication, the views of Koch on the nature and cause of cholera have been expressed with so much precision and definiteness, and Koch being justly considered a great authority on questions concerning the relation of micro-organisms to infectious diseases, it is not to be wondered at that a great section of the general and medical public take it for granted that the whole problem of the nature and cause of cholera is definitely and satisfactorily solved.

Now, what are the observations and conclusions of Koch? Koch failed to discover in the blood and other tissues of patients dead of cholera anything that could be identified as infective particles. He failed to find any kind of micro-organisms, and he therefore looked to the alimentary canal, which, as is well known, is the seat of grave disturbances. In the intestine he found this: In some cases the lower portion of the ileum, particularly just above the ileo-cæcal valve, was of a dark brown color, owing to hemorrhage into the mucous membrane, which in some instances amounted to necrotic and diphtheritic changes in these latter instances the contents being of the nature of a sanguineous dirty-looking fluid. In other cases the redness was much slighter, limited to the margin of the solitary lymph follicles and Peyer's glands. In comparatively few instances, however, the mucous membrane showing very little change, being slightly swollen, less transparent than normally. The solitary follicles and Peyer's glands were prominent, the whole of the mucous membrane was slightly red, but there was nowhere capillary hemorrhages.

In these cases the contents of the intestines were, more or less, a fluid, like rice water, in which were suspended the characteristic flakes, *i. e.*, masses of detached epithelium cells held together by mucous.

The last two sets of cases Koch considers as the typical and acute forms of cholera, and in such cases he discovered in the flakes of the intestinal fluid and in the reddened mucous membrane, particularly in those cases in which the margin of the Peyer's glands showed the characteristic redness, peculiar bacteria, which he called "comma-shaped bacilli." In sections through such part of the mucous membrane, these "comma bacilli" were seen to have penetrated from the free surface into the cavity of the Lieberkühn's crypts, and into spaces produced by the detachment of the epithelial lining of these crypts from their *membrana propria*. In other cases, other (putrefactive) bacteria could be seen penetrating into the mucous membrane, but the "comma bacilli" were leading.

In acute typical cases of cholera the rice-water stools showed the comma bacilli in greater numbers the fresher the stools. Koch found this condition to be characteristic of cholera; he saw it in Egypt, in Calcutta, and more recently in Toulon, and not finding the comma bacilli in any other disease except cholera, he is led to attribute to them an important relation to cholera. Seeing that the more typical and fresher the case, the more pronounced the presence of the comma bacilli is, seeing that in the most typical or acute cases the mucous membrane of the intestine is so crowded with the comma bacilli that it represents, as it were, a pure cultivation of them, he concludes that these bacilli are the true cause of the disease.

To explain the manner in which these comma bacilli produce the disease, he assumes that a chemical ferment is elaborated by the comma bacilli, analogous to the septic or putrid ferment produced by putrefactive bacteria; this ferment, while at the same time killing and detaching the epithelium, is being absorbed into the general system, and then sets up all the symptoms constituting cholera. The more acute a case the greater the number of the comma bacilli in the intestine, and consequently the greater the quantity of this chemical ferment produced. This—the presence of large numbers of comma bacilli in the mucous membrane—is a point, the verification of which being obviously of essential importance, Koch has been able to ascertain to hold good in a large number of cases, for he found that the more acute the case the more conspicuously was the mucous membrane of the ilium a pure cultivation, and also the more affected the mucous membrane, the more numerous were the comma bacilli. Cases that do not run an acute course, *i. e.*, in which the disease passes the first stage, show on *post mortem* examination less conspicuously the comma bacilli, there being grave disorganizations of the membrane, and consequently numerous putrefactive bacteria.

The comma bacilli are then, according to Koch, the producers of the cholera poison, and the intensity of the disease is independent in a direct ratio on the number of comma bacilli present in the mucous membrane of the ilium. A very necessary conclusion from these statements is this, *viz.*, that the rice-water stools, and particularly the mucous flakes suspended in the clear fluid (being charged with the comma bacilli) are the vehicles of the virus, and the minutest quantity of these materials finding entrance into the small intestine of a person multiply in the mucous membrane, and produce the chemical ferment acting as the cholera poison, the more rapid the multiplication of the comma bacilli, the greater their numbers and the more acute and intense the disease; as long as their number is limited, the amount of the ferment is too small to produce any other symptom except diarrhoea, but as their number increases, the amount of ferment increases, and a general infection of the system with all the typical symptoms ensues. A very remarkable fact stated by Koch is this: If a mucous flake of the fresh rice-water stool, or of the fresh mucous membrane of an acute typical cholera case be placed on a piece of linen or cloth, and this be kept damp, being placed in a moist cell or chamber (under a bell glass) at ordinary temperature, it is found that after 24 to 48 hours the comma bacilli have increased enormously in numbers, later on putrefactive bacilli make their appearance, and by their multiplication gradually suppress the comma bacilli.

Koch has cultivated the comma bacilli artificially on sterilized media of different kinds; they grow well in milk, which is not curdled by them in blood serum, particularly in nourishing gelatine in broth in agar-agar with broth and peptone. Nourishing gelatine (composed of gelatine, peptone, and meat extract), is liquefied by the comma bacilli: the Agar-agar mixture is not. The nourishing medium must not be too dilute. The behavior of the comma bacilli in nourishing gelatine differs from that of other bacilli, inasmuch as the growth



forms peculiar funnel-shaped depressions. They grow well at ordinary temperature, but best at a temperature varying between 30 and 40 centigrades. The growth ceases below 16 centigrades. They do not form spores under any condition, but having reached in their multiplication a maximum, gradually shorten and die. The comma bacilli require for their growth an alkaline medium. If the nourishing medium contains acid the bacilli cannot grow or multiply; and if free access of oxygen is prevented no growth of the bacilli can take place. The bacilli are killed by drying, and they are not killed by freezing to 10 centigrades.

Various substances inhibit the growth of the comma bacilli. Iodine must be used in greater strength than in the case of other bacteria, similarly alcohol. Sulphate of iron in 2 per cent. mixtures, alum 1 in 100, camphor 1 in 300, carbolic acid 1 in 400, quinine 1 in 5,000, perchloride of mercury 1 in 100,000.

The comma bacilli are about one-half or two-thirds the size of the tubercle, bacilli are thicker, and they possess a curvature, which, as a rule, is not greater than that of a caraway seed, but occasionally amounts to a semi-circle. After division the two bacilli may remain joined endwise, their curvature being directed in opposite directions, and thus an S-shaped organism results. Occasionally, in gelatine, and particularly in broth, Koch saw them grow (by rapid division, and remaining endwise) into a sort of spirillum, not unlike a spirillum tenue.

These views of Koch, it is evident, favor in an eminent degree the theory of contagiousness, inasmuch as the comma bacilli directly derived from the fresh evacuations are considered as the contagium vivium. Particles of these evacuations, linen and clothing soiled with them, provided these articles remain in a damp state, water, food, and other articles contaminated with comma bacilli can, under this view, directly convey the disease, if they find access to the alimentary canal, particularly to the small intestine. There exists a great many *a priori* difficulties in accepting this view of Koch. Foremost is the well-known fact, observed over and over again, that direct contagion does not exist at all, or is of the greatest variety; the attendants of a cholera patient, the persons living in the same room, physicians and nurses, persons occupied in handling and removing the evacuations of a cholera patient, are, according to almost all accounts, particularly exempt; if the comma bacilli were in reality the contagium, then it is impossible to understand why direct contagion should not be a very common thing. (It would be quite unjustifiable to maintain that the extraordinary panic which seized a section of the French and Italian nations on the visitation by the cholera in the summer of 1884 was caused by this theory of the comma bacilli, but considering the authoritative position that Koch occupies, and considering the very decided way in which Koch, his government, and the daily and most of the medical press gave expression to this view, it is not unreasonable to say, that that panic, although not caused, derived material support from it, for has it not been preached from day to day that the cholera evacuations are full of comma bacilli, and that the comma bacilli are the contagium of cholera? What, after this, is more natural than that the general public, reading such statements as coming from the highest authorities, should take up and spread the cry?) Again, it is well established by the researches of Pettenkofer and others, that between the introduction of the cholera virus into a new locality and the outbreak of the disease in the form of an epidemic, there is always a considerable lapse of time; according to Pettenkofer the cholera matter introduced into a locality must, before becoming active virus, pass a certain stage of development in the soil, this soil must at the same time be of a definite character, and only after having undergone these changes and having had access to the system of persons can produce the disease. If the comma bacilli of the evacuations were the actual *materies morbi*, such notorious immunity from cholera as is enjoyed by Versailles, by Lyons, Birmingham, by ships on the high seas, etc., could not easily be understood. In the several epidemics of cholera that visited Paris, thousands of persons fled from Paris to Versailles; some of them had contracted the disease in Paris, were ill in Versailles, but the disease did not spread in Versailles to other persons; if the comma bacilli were the contagium, surely, when introduced into Versailles, there is no possible reason why, having taken a footing in Versailles, they should not have exerted the same power there as in Paris;

the conditions under which in Paris the comma bacilli can find entrance into healthy persons (linen and cloth contaminated with cholera evacuations, water, food, and other articles) are precisely the same as in Paris; the people in Versailles do not differ in respect of personal cleanliness, habits, etc., from those of Paris, and notwithstanding all this the disease did not spread in Versailles. The same can be said of Lyons and other places. A fact as well established as to have led to the adoption of radical and thoroughly efficient measures is this, that if into any ship lying off an infected country cholera cases are introduced, or cholera breaks out among the *personnel*, after removing the ship to the high seas cholera cases cease and the epidemic dies out; if the comma bacilli present in the evacuations were the disease germs such a thing would be impossible; the whole *personnel* of such a ship, at any rate all susceptible persons, would become liable to attack. Another noteworthy observation, constantly acted on in India with conspicuous success, is this—when in any military cantonment cholera cases occur, the troops are at once moved into camp and cholera ceases; surely no amount of shifting of the troops could in the least affect comma bacilli; for as long as there is one case of cholera amongst the troops, there would be available sufficient numbers of comma bacilli to infect any number of persons.

Another great difficulty in accepting the theory of Koch is this: The comma bacilli can not, according to Koch, exist in acid media, and therefore when introduced into the stomach, this mode of infection being, according to Koch, the general one, they could not pass unscathed into the small intestine (the ilium being their true breeding ground). In an epidemic of cholera it is notorious that not only those become attacked by cholera that suffer from some gastric disturbance, for many persons previously in perfect health become subject to the disease, and a dyspeptic condition of the stomach ought to be the very best protection against cholera, seeing that in such a state it is hyperacidity which is present in the stomach, and therefore the comma bacilli ought to have less chance. An empty stomach, that is in the morning before any food has yet entered the stomach, would be the only condition in which the comma bacilli could pass unscathed into the small intestine; but it can hardly be seriously assumed that this is the time when infection is carried out in all cases of cholera. If the comma bacilli entered the stomach with the first morsel of food they would be attacked by the gastric juice, the secretion of which is immediately set going, and since they would have to sojourn in the stomach for some time like all the rest, they would, do doubt, be killed. Thus we see that here are many weighty facts against accepting Koch's view as to the specific nature of comma bacilli.

In order to make good the proposition that the comma bacilli are specific, it is necessary for Koch to show (1) that these comma bacilli occur only and exclusively in cholera; (2) that the comma bacilli being absent from the blood and other tissues, must be present in the tissues of the small intestine in acute typical cases in enormous numbers, so as to cause the production of a correspondingly large amount of the chemical ferment—the direct poison; (3) that not only differ the comma bacilli from other similar putrefactive bacilli as regards shape, but also as regards other characters, such as growth, behavior toward reagents, etc.; and (4) that the comma bacilli of pure cultivations are capable of producing the disease when introduced into the animal system. As regards No. 1, Koch maintains that the comma bacilli occur only and exclusively in the intestine of patients suffering from cholera, and hence regards their presence as characteristic of cholera.

The examination by Koch of a number of cases of diarrhœa (infantile diarrhœa, diarrhœa due to other causes, dysentery, cholera nostras, and a variety of other conditions) invariably proved that comma bacilli were absent. (In a subsequent publication, *Deutsche Woch.* No. 45, 1884, Koch has modified this view, since he admits that comma-shaped bacilli occur also in other conditions.) And for these reasons Koch is of opinion that in doubtful cases the presence of comma bacilli in the stools is of an infallible diagnostic value. From these statements of Koch we must differ most decidedly. In typical rice-water stools of cholera cases, however fresh, there occur, as is well known, a variety of micro-organisms: (*a*) various species of micrococci, differing from one another in size of the elements in the mode of aggregation, some



forming dumb-bells, and curved chains, and zooglœa, others forming only dumb-bells and sarcina-like groups, but not chains; (b) various species of *bacillus subtilis*, differing from one another in the length and thickness of the elements; (c) *bacterium termo* and *lineola*; this bacterium seems to possess in Bombay a wide distribution, since many artificial cultivations appear contaminated with it, but it is never missed in cholera stools; (d) *vibrio rugula* of Cohn (Beitr. z. Biol. d. Pfl. 11.); but there are sometimes more than one species of them, differing from one another in the length and thickness of the elements; (e) spirillum, in all respects identical with the spirillum tenue of Cohn (*spirillum denticola*, *spirillum Obermyeri*), is often found in great numbers in cholera stools, particularly those that have been kept standing for several days; but we have seen also tolerably fresh stools containing a great number of them, although there were stools in which they were absent or only scarce; these spirilla, when abundant, present themselves in all shapes and lengths, from that of a single turn to that of three or four turns, either conspicuous by being twisted spirally or only more or less wavy; (f) *Koch's comma bacilli*; these are caraway-seed shaped curved organisms, with very slightly pointed or blunt ends; their length, measured like the tendon of the arch, varies between 0.0017<sup>mm</sup> and 0.0026<sup>mm</sup>; they differ slightly in length and thickness in the same sample, but show greater differences in the amount of curvature. In the best examples the curve amounts to as much as half a circle; in most others it is only comparatively slight.

Now and then one comes across two comma bacilli joined end to end, but so that their curves point in opposite directions, and nearly an S-shaped figure is produced.

NOTE 1.—Since the name of comma bacillus has been now universally adopted we will retain it under protest. Its claim of being compared to a comma is in no way admissible, especially not to English readers, since an English comma is distinctly hook-shaped; its resemblance to a comma as used by the Germans in writing is, however, more real. Nor is its claim to the name of “bacillus” more justifiable, since by “bacillus” a cylindrical or rod-shaped bacterium is understood. A great deal of misunderstanding has been caused by this unhappy comparison of Koch's cholera organism to a comma bacillus; most English microscopists when first reading of it expected to find an organism of a distinctly hook-shaped appearance, and some went so far as actually to identify it with a hook-shaped something with thickened end. Thus, Dr. Bristowe states in the “Lancet” that some years ago, when engaged in a microscopic inquiry into cholera, he had actually seen (and drawn in his notes, unpublished till urged by Dr. Wilks) the “comma-shaped bacillus,” and he figures a huge hook-shaped or rather club-shaped corpuscle with a thickened curved head, which he thinks corresponds to the cholera organism of Koch.

Dr. Bristowe's “organism” as much resembles the comma shaped bacillus of Koch as a cylindrical epithelial cell of the intestinal mucous membrane resembles a bacillus anthracis; Dr. Bristowe figures are, no doubt, distorted and injured epithelial cells.

Similarly, Dr. V. Carter, of Bombay, anxious not to be behindhand in claiming priority in having identified Koch's cholera organism, gave an actual demonstration of it to the Bombay Medico-Physical Society, and published also drawings and descriptions in the Lancet, September 5, 1884. One of us had seen the comma bacilli of Koch in specimens of rice-water stools and artificial cultures prepared by Koch himself, and therefore knew exactly what they were like. On our arrival in Bombay, Dr. Carter was soon informed that in his specimens and drawings submitted for examination the comma bacilli of Koch were altogether absent, and that his drawings (the same as published subsequently in the Lancet), showed a variety of spirilla tenua that have nothing whatever to do with the real comma bacillus. The coma-shaped bacilli of Koch, as described sub. f., have no claim to the name of bacillus (Cohn), for under this name an organism is understood which, in its elements or single bacilli, is straight, rod-shaped. Owing to the shape of Koch's cholera organism, and owing to the fact that when, after the division of one, the two offspring remain connected end to end so as to form an “S,” it is more appropriate to consider it as a *vibrio* or spirillum, for a curved organism of this nature is considered to be a *vibrio* or spirillum, and is distinct from bacillus. From this and other facts presently to be mentioned, Koch's comma bacillus ranks as a *vibrio* or spirillum. The comma

bacilli are, then, present in the rice-water stools of cholera patients, but their number is subject to very great variations; while in some they are easily found, in others it is difficult to meet with one. However, in the flakes of the fresh stools they are generally found in sufficient numbers to be easily detected, but we have seen typical fresh stools of acute cholera cases in which their number was so limited in the flakes that a careful search revealed only in one or the other field of the microscope a comma bacillus. In stools of some hours and days they are not found so easily, being almost crowded out by the other organisms. In a few cases of cholera which during the first 30 hours had passed a very large number of evacuations, some of them obtained during the second day of illness were almost clear watery fluid, in which were suspended minute mucous flakes; these flakes consisted almost entirely of hyaline mucus, and included only few cells; a very large number of comma bacilli, but not to the exclusion of minute straight bacilli, were met with in the fluid and in the flakes. In other typical cases, during the first day of illness, the mucous flakes of the rice-water stools contained large numbers of other bacteria besides the comma bacilli. (*g*) In some rice-water stools we have met organisms which are no doubt comma bacilli, but differ from the ordinary typical examples of comma bacilli in this, that they are distinctly semi-circular, in some of them the ends are turned inwards, and then they represent rather more than half a circle. These semi-circular organisms occur in two sizes, (*a*) either such as correspond to long comma bacilli with ends turned inward, or (*b*) such as correspond to very short comma bacilli. This latter variety is sometimes met with in great numbers, and their uniform and minute size are very typical features in them (see Fig. 12). We were at first inclined to consider them as a distinct species, but a more careful analysis left no doubt that they are only a variety of the comma bacilli. Both the large and small semi-circular organisms grow, as is exemplified in the specimens, into cork-screw-shaped spirals, the former into spirals of much larger curve than the latter.

In cultivations in broth Koch found the cholera organism in forms which made him doubtful whether it is not rather a spirillum (see below), or at any rate an intermediate form between bacillus and spirillum. These forms (see his pamphlet, p. q., Fig. Aa) are, however, quite reconcilable with the acceptance of the "comma bacillus" being a minute form of vibrio. In cultivations in fluids (broth, liquefied gelatine, etc.) the commas grow through the S-shaped form into vibrios of several wave lengths, similar to a spirillum, but this is not, therefore, to be considered a true spirillum, since the typical organism, as shown in cholera material and in cultivations, is a single curved element, or a couple of them arranged like an S.

Also, in mucous flakes kept three days, of an acute typical case, the comma bacilli were found growing into S-shaped and spirillar forms.

In this instance, although putrefaction was going on, there were mucous flakes containing enormous numbers of commas, S-shaped, and many-waved vibrios, all of the same thickness, but of slightly greater thickness than the commas in the fresh flakes. They are easily distinguishable from the spirilla *tenua* one meets in putrid stools, for these latter are very much finer, and stain differently in aniline dyes. So much for Koch's generalization that the comma bacilli are inhibited in their growth and even destroyed by putrefaction.

This cholera bacillus, or, at any rate, one that in morphological respects appears identical with it, occurs also in the stools of cases of diarrhea.

In an epidemic of diarrhoea that occurred in the autumn of 1883 in Cornwall, the stools of patients contained, besides various species of micrococci, of bacillus subtilis, and spirillum *tenua*, also curved organisms, which it is impossible to distinguish from the comma bacillus of cholera stools; in size they are the same, in being curved they are the same, and in some the ends being slightly pointed or blunt they are the same. They occurred not less numerously than they are sometimes found in cholera stools. In several cases of dysentery, besides the ordinary putrefactive organisms and spirilla *tenua*, comma bacilli were found.

In cases of enteric catarrh comma bacilla could be detected. In a case of chronic phthisis, of whom a post-mortem examination was made, the mucus of the small intestine, although free of any tubercle bacilli, contained, besides other putrefactive organisms, also comma



bacilli, and in this case they were so distinct that there was no difficulty in identifying them, and they were as numerous as in many cholera stools that we have examined. In the stool of a case of diarrhea in a child, suffering from chronic peritonitis (February, 1882), there are present in specimens stained with Spiller's purple numbers of comma bacilli, which it is impossible to distinguish from choleraic comma bacilli; in size, shape, and general aspect they appear identical. On the whole, then, we maintain, contrary to Koch's emphatic statement, *that comma bacilli occur also in other cases of intestinal disease than cholera*.

And from this it must be clear that the statement of Koch that the commabacillus is pathognomonic for cholera, and therefore is a valuable guide in deciding whether a doubtful case is or is not a case of cholera, is not borne out by our observations. A point on which Koch and his pupils lay great stress is this: they admit now, since Koch's return to Berlin, that comma-shaped bacilli do occur in other conditions than cholera (Finkler and Prior found them in stools of cholera nostras, Lewis found them in fluid of the mouth of healthy persons, see below), but they say the commabacillus of cholera stools is different in size from those occurring in other conditions, and, what is much more important, by artificial cultivation it can be shown that the choleraic commabacilli behave altogether differently from other commabacilli. As regards this second point, we shall return to this when speaking of the behavior of the commabacilli in artificial cultivations; here we wish to state that the commabacilli occurring in our cases of intestinal catarrh above mentioned are no doubt slightly thicker than most of the choleraic commabacilli in rice-water stools, but—and this can not be too strongly insisted on—a careful comparison of the choleraic commabacilli in different rice-water stools show undoubtedly differences in thickness, besides conspicuous differences in length. And, more than that, cases were examined in Calcutta (typical and rapidly fatal cases) in which in one and the same specimen of the same rice-water stool the differences between the commas were most distinct, some being at least three or four times the thickness of others. Such differences in thickness, and still more in length, between commas are equally striking in the mucus flakes taken from the ileum of typical cases of cholera, as will be mentioned presently.

That the commabacilli should in some cases of cholera, particularly those with typical rice-water stools, with or without many mucus flakes, be very abundant may simply mean that here the commabacillus finds the most suitable conditions for growth, more suitable than any other bacillus, although, as a matter of fact, we have not found that, except in a few cases, it always predominates over other bacilli, particularly very short, thin, straight bacilli, to be mentioned below. The statement of Koch that in acute typical cases the commabacilli are found chiefly and almost exclusively in the mucus flakes of the lower part of the ileum—a statement borne out by our observations—does not harmonize, it appears, with the assumption that the commabacilli are the cause of the disease, since in several acute typical cases there is no difference as regards the aspect of the intestine, the amount of fluid and flakes contained in the cavity of the intestine, and the anatomical changes of the membrane between the lower and upper portions of the ileum as well as jejunum.

NOTE 2.—In order to explain the causation of the disease by the commabacillus, Koch assumes that, it being absent from the blood and present only in the small intestine, a chemical ferment, which is the actual poison, is secreted by it, and on the amount of this the severity and rapidity of the illness depend; in the typical acute cases a large amount of this chemical ferment is being produced, absorbed by the system, and therefore death rapidly ensues. And this, Koch states, is in accordance with the observation made by him, that in these instances the commabacilli are so numerous found in the mucous membrane itself, particularly in the lower part of the ileum, that this appears almost like a pure cultivation of the bacilli. If this were really the case, viz, if it could be shown that in acute typical cases of cholera not only the flakes composed of the detached epithelium and mucus, found in the cavity of the intestine and on the surface of the mucous membrane, but also, as Koch states, the superficial layers of the mucous membrane of the congested ileum are loaded with commabacilli and nothing else, this would be a remarkable fact, and there would be strong

grounds for believing that the commabacilli must in some way or another be related to the morbid process, although it would not necessarily follow that these bacilli must, as a *conditio sine qua non*, be the actual cause of the disorder.

Now, our observations are in direct opposition to these statements of Koch. It is difficult to explain how such a statement could have been made. Several cases of acute typical cholera were subjects of *post mortem* examinations. Death had followed in some within from 16 to 28, in others from 8 to 12, hours. The *post mortem* was made in some within one, in others within half or a quarter of an, hour. The ileum, and, as a matter of fact, the whole of the small intestine, was either slightly and uniformly injected and its mucous membrane slightly tumefied, the cavity both of the jejunum and ileum being filled with clear watery fluid, in which were suspended large numbers of the typical flakes. There was no difference noticeable in this respect between the lower part of the ileum and the rest of the small intestine. In a few cases in the lower portion of the ileum the solitary follicles and Peyer's glands were distinct, and presented either a slight redness or only redness at the margin. Koch's statement that in acute typical cases of cholera the Peyer's glands and solitary glands of the ileum are enlarged, and on naked-eye inspection already visible by a slight injection of their marginal portion, is not confirmed by our observations, since several acute typical cases came under our observation in which such a condition was not noticeable—that is to say, cases coming under the category of the pure typical cases of Koch, in which the mucous membrane ought to be almost "a pure culture of comma bacilli."

The microscopic examination (carried out precisely after the same methods as used by Koch, *i. e.*, spreading out of a layer of mucus, drying it, and then staining with gentian violet, Spiller's purple, or methyl blue) revealed in some cases in the flakes taken from the superficial layer of the membrane a goodly number of small bacilli and also a considerable number of comma bacilli, besides, of course, amorphous mucus and lymph corpuscles and the detached cylindrical and epithelial cells—some perfect, others degenerating and breaking down—as well as cells of the basement membrane. In other cases there were almost no putrefactive organisms present; only in one or the other field of the microscope could a fine, short, straight bacillus be detected, and in addition a few comma bacilli; and in still other cases, besides the mucus, the perfect or degenerating epithelial cells, we could detect also, but at great intervals, 1, 2, or 3 comma bacilli and a similar or greater number of fine, short, straight bacilli. But in 2 cases more favorable for examination, death occurring after 12 and 18 hours, respectively, since the first symptoms, and *post mortem* examination being made within half an hour to an hour, there were found in the flakes lifted off with a scalpel from the superficial layer of the mucous membrane remarkably few comma bacilli; many fields of the microscope contained none, others 1 or 2, but there were present, though in small numbers, the fine, short, straight bacilli. It must be stated that this does not refer to a very minute particle of a flake spread out on the cover-glass in a thin film, but this and the previous statements refer to preparations in which a considerable mass of the flakes had been spread on the cover-glass.

A point which appears to us of primary importance is this, that in some typical rapidly fatal cases when the examination was made soon after death the comma bacilli were very scarce in the mucous flakes, while when the post-mortem examination was delayed, or when the patient remained *in articulo mortis* for many hours, the number of the comma bacilli was much greater in the mucous flakes. Thus we find, for instance, as stated in the table on a following page, that the comma bacilli were very scarce in cases 14 and 16 and 23, post-mortem made after half, three-quarters, and  $1\frac{1}{2}$  hours, respectively; abundant in case 2, post-mortem after 4 hours; and when they were abundant in the lower part of the ileum in early post-mortem, also other bacteria were very abundant.

In the following is given a tabular statement of the occurrence of bacteria in the mucous flakes taken from the lower part of the ileum of typical rapidly fatal cases, the ileum was slightly reddened and filled with clear fluid, in which were numerous typical flakes. The numbers attached to the cases indicate the number in the total series of cholera cases examined in Bombay and Calcutta:



(1) Case 2.—Death after 40 hours. Post-mortem made after 4 hours. Comma bacilli abundant, small and large straight bacilli.

(2) Case 11.—Death after 18 hours. Post-mortem after half an hour. Comma bacilli tolerably numerous; they vary in length, and particularly in *thickness*. Large, straight bacilli exceedingly numerous; minute straight bacilli.

(3) Case 14.—Death after 12 hours. Post-mortem after half an hour. Comma bacilli very scarce. Few other bacteria.

(4) Case 16.—Death after 18 hours. Post-mortem after three-quarters of an hour. Very few comma bacilli. Exceedingly numerous, small, straight bacilli, singly and in clumps. Other kinds of bacteria.

(5) Case 23.—Death after 20 hours. Post-mortem after 1½ hours. Various species of bacteria; micrococcus, bacterium termo. Minute straight bacilli in clumps.

(6) Case 32.—Death after 27 hours. Post-mortem after 2 hours. All kinds of straight bacilli in great numbers. The small straight bacilli numerous. Comma bacilli tolerably numerous; they are of different lengths and *thickness*.

(7) Case 35.—Death after 13 hours. Post-mortem after quarter of an hour. Comma bacilli tolerably numerous. The small straight bacilli exceedingly numerous.

(8) Case 48.—Death after 14 hours. Post-mortem after half an hour. Great abundance of comma bacilli and also numerous minute straight bacilli.

(9) Case 51.—Death after 9½ hours. Post-mortem after 1 hour. Various kinds of bacilli. The minute straight bacilli in extraordinary numbers. Comma bacilli of three different kinds, distinct by their various thicknesses, some exceedingly minute, others five and six times as big, and a third variety corresponding in length and thickness to the typical comma bacilli of other cases. The first variety in very large numbers, forming continuous masses. Numerous small semicircular commas, corresponding in size to the small variety of the above commas.

All these organisms were as numerous in the free flakes as well as in those still on the mucous membrane.

Other cases, although typical and rapidly fatal, but in which the ileum did not contain the clear watery fluid with mucous flakes, are not included here.

This case 51 is in many respects a very remarkable one, (*a*) on account of the uniform appearance of the whole ileum; (*b*) on account of the large number of typical mucous flakes suspended in the clear fluid which filled the cavity of the ileum; (*c*) on account of the comma bacilli being present in, at least, three distinct varieties; it is impossible to assume that the comma bacilli figured in Fig. 12 at *a* should be the same as those at *b* or those at *d*; (*d*) on account of the great number of semicircular and also circular minute commas; (*e*) on account of the total absence of any bacteria from the mucous membrane itself, the epithelium of the surface being detached *en masse*; (*f*) on account of the enormous number of small commas and small straight bacilli, as also other kinds of bacteria already one hour after death, the illness having lasted only 9½ hours.

Fine sections made of the mucous membrane of the above typical acute cases of cholera, after hardening the intestines in alcohol or Muller's fluid, particularly the first (also used by Koch), and stained in various aniline dyes (gentian violet, in several modifications, Spiller's purple, methyl blue, magenta, after Ehrlich's, Weigert's, Koch's, and other methods), revealed *the total absence* of comma bacilli from the mucous membrane itself, from the tissue of the villi, from the Lieberkuhn's follicles, and from the lymphatic tissue of the Peyer's and solitary glands; the epithelium of the surface of the villi having become detached during life has not generally kept its place in the hardened intestine, but in many places the epithelium of the surface, as well as that of the Lieberkuhn's follicles, although loosened and slightly raised from the mucous membrane, had nevertheless kept its position and was fixed during the hardening; and in these places *the comma bacilli or any other organisms are conspicuous by their absence*; they are nowhere to be found; they are simply absent.

A case very remarkable in this respect is the following: A woman servant died in the medical college, Calcutta, of typical cholera, the illness having lasted only nine hours and a

half; she was taken ill at 10 a. m. on 19th November, and she was dead at 7.30 p. m. the same day. Post-mortem was made an hour later. Body was extremely well nourished, the whole of the small intestine was slightly injected and filled with clear watery fluid, in which were suspended a large number of typical mucous flakes. In those of the lower part of the ileum on microscopic examination were found very large numbers of exceedingly minute comma bacilli, smaller than the typical ones of other cases, but there were present also many comma bacilli, somewhat larger and of the size of the typical ones, and further a great many comma bacilli conspicuous by their thickness and length, as much as six times as big as the first variety; there were present in large and small masses everywhere the small straight bacilli; finally, there were numerous micrococci in chains and dumb-bells, and thick straight bacilli singly and in chains. In fact, the mucous flakes seemed to be one mass of bacteria. Sections through the hardened mucous membrane showed that the epithelium of the surface was gone as a whole, but nowhere in the tissue (including the Peyer's glands) could there be detected a trace of comma bacilli. If what Koch describes on page 6 of his pamphlet—viz. the presence of large numbers of comma bacilli between the epithelium of the Lieberkuhn's follicles and the membrana propria, and extending into the cavity of the follicles and into the surrounding lymphatic tissue of a Peyer's gland—were a typical representation of what is the case in an acute and typical case of cholera, then we might reasonably expect to occur again in typical cases. But this is absolutely not the case. Our preparations were made after the same method as Koch's, they were well prepared and well stained, and if comma bacilli had been present we should not have failed to bring them out, for in preparations of some cases other micro-organisms, such as micrococcos, bacillus subtilis present on the surface and in the superficial epithelium layer are brought out very conspicuously. In two cases only were there present in sections through the Peyer's glands near the ileo-cæcal valve comma bacilli in some places around Lieberkuhn's crypts, and also scattered here and there amongst the superficial parts of the lymph follicles. But besides the comma bacilli, and in great majority, were straight bacilli, which with the comma bacilli could be traced from the broken surface into the depth of the mucosa. As one of these is a good case, in which comma bacilli were found in the mucosa, but with a majority of straight bacilli, we will give for better estimation the history of this case. The patient, aetas. 30, was attacked with vomiting and purging at 4.30 p. m. on the 6th of October; he was admitted into the J. J. Hospital, Bombay, at 7.30 p. m. on October 7. When admitted he was deeply collapsed, pulse imperceptible, features sunken, extremities cold, no urine. He died at 6 a. m. on October 8. Post-mortem at 8.30 a. m. The patient was evidently moribund from 7.30 p. m. of October 7 till 6 a. m. of October 8, *i. e.*, for nearly 12 hours; in addition to this the post-mortem was made two hours and a half after death; the temperature of the air was above 75 Fahrenheit. No wonder that under all these circumstances the tissue of the bowels should become invaded by micro-organisms. In another case of acute typical cholera, where the post mortem had been made 14 minutes after death, but where the patient had been moribund from 9 a. m. till 3 p. m., sections through the hardened Peyer's glands and mucosa of the ileum showed the epithelium of the surface, as well as that lining Lieberkuhn's follicles, bodily loosened and raised from the mucosa, but fixed in position during hardening. While there was total absence of comma bacilli here or anywhere else in the mucous membrane and lymph follicles, there were nevertheless in some places on the surface minute groups of putrefactive bacillus subtilis, and from here they entered into the spaces resulting from the detachment of the epithelium of the Lieberkuhn's follicles from the membrana propria. And even capillary blood vessels of the lymph follicles near the denuded surface were found crowded with putrefactive bacilli and micrococci. In a third typical case, death after 10 hours, post-mortem after half an hour, there were present numbers of straight putrefactive bacilli in the tissues of the villi and around the bottom of the Lieberkuhn's follicles, but only here and there could a comma bacillus be found close to the epithelium of the surface.

The preparation, then, described by Koch on page 6 and figured on page 7 of his paper, is an exceptional one, and is not typical of cholera. As many typical cases as were examined



by us, as often did we miss such a condition. It follows from this that the statement of Koch that in acute cases the mucous membrane of the ilium contains so great a number of comma bacilli as to represent almost a pure cultivation of comma bacilli is in direct opposition to the facts observed.

And if this statement of Koch is not in conformity with the facts, his inference that the large number of these comma bacilli produce a large quantity of the chemical ferment, and therefore an acute illness is in no way justified, and his whole edifice as to the relation of the comma bacillus to the disease having thus lost its chief support (viz, vast numbers of comma bacilli supposed to be present in the mucous membrane in acute cases) falls to the ground.

As must be evident to every one who has carefully read Koch's description and arguments, the constant presence of crowds of the comma bacilli in the mucous membrane in the lower part of the ilium in acute typical cases of cholera forms, as it were, the foundation for his whole theory of the relationship of these bacilli to the disease; and, therefore, if even in one single instance only of acute typical cholera (and with so much greater force in several cases) it can be shown that the comma bacilli are absent from the mucosa of the lower part of the ilium; then the theory that these bacilli are essential in producing the illness must be abandoned.

Some of the ardent supporters of Koch's theory, after it has been shown that the mucous membrane of the ilium or of any other part in the acute cases of cholera, provided the examination be made immediately or very soon after death, is absolutely free of comma bacilli, might and probably will nevertheless cling to the comma bacilli as the cause of cholera, saying: But the comma bacilli are present in the cavity of the intestine, and although absent from the mucosa itself might nevertheless be the producers of the chemical ferment, seeing that they are present in such large numbers. As answer to this it may be repeated, (1) that there are acute cases in which the comma bacilli are very scarce indeed, even after the disease has well set in; that they should have been present in sufficiently large numbers in the lower part of the ilium before the symptoms appeared in order to produce the large amount of chemical ferment which is to be absorbed—for this is what is meant by absorption of the chemical ferment, for no absorption can go on in an intestine during the attack itself, when the wall of the stomach and intestine discharge such enormous quantities of fluid as fast as they can—must be evident to every one to be an absurdity; an assumption of this kind would imply that the comma bacilli are present in the fœcal matter in the lower part of the ilium before the setting in of the disease, and consequently they would have to remain here long enough to produce the virus; but for such an assumption there is not a tittle of evidence, and all our knowledge of the physiology of the intestine is against it; (2) that the whole of the small intestine presents in some acute typical cases the same appearances, viz, slight congestion, the cavity filled with clear fluid, in which are suspended the typical mucous flakes, and the great scarcity indeed of comma bacilli in the flakes taken from the jejunum and upper part of the ilium; and (3) that the comma bacilli are present only in dead tissues, for the mucous flakes are in all respects dead tissue, and they are found more numerous the lower down we go in the cavity of the ilium; these two facts point clearly to the comma bacilli being putrefactive organisms. As mentioned on a previous page, the flakes typical of the rice-water like contents of the intestinal canal consist chiefly of perfect or degenerating epithelial cells and mucus, and, as has also been stated, there are present in them sometimes many comma bacilli, and also other bacilli.

Out of several typical acute cases there were two in which, with the flakes taken within half an hour after death from the superficial layer of the mucous membrane of the ilium, pure cultivations of comma bacilli were established by one of us on bits of linen (after Koch) kept moist under a bell glass, as well as in test tubes containing sterilized nourishing material. Just as Koch has found it, after from 24 to 48 hours' exposure to the ordinary temperature (in Bombay this was about 80° F.), the mucous flakes placed on the linen were crowded with comma bacilli and the preparations obtained were identical with those figured by Koch in his memoir in Fig. 3, except that in our specimens the semi-circular forms delineated by Koch were absent;

after 48 hours various putrefactive bacteria, micrococci, and bacteria made their appearance and crowded the comma bacilli out. In several other typical acute cases this mode of cultivation (*i. e.*, on damp linen) yielded no result since from the outset numbers of putrefactive organisms were present. But also in one of the above two cases, amongst a number of cultures thus established, only one was successful for comma bacilli, and from this it appears a little too sanguine on the part of Koch to recommend (see his Memoir, page 62) that in a case of doubtful nature, viz, whether cholera Asiatica or cholera nostras, all one has to do to decide it one way or another is to make microscopic specimen of a piece of linen soiled with the flakes of the evacuation or a culture on linen and to see whether there are present comma bacilli. This method, if successful, requires a good deal of luck; as a rule, in the majority of instances, comma bacillia will be found absent, since in such specimens, even when taken from typical cholera cases, the commas have not developed, owing to crowds of bacteria of other kinds, for, as mentioned before, in the majority of instances the flakes of the rice-water stools contain (from the outset) already various kinds of other bacteria in great numbers.

As has been indicated above, the comma bacilli seem to thrive best under conditions such as obtain in the lower part of the ilium, *i. e.*, mucous flakes suspended in a clear albuminous fluid, and for this reason it seems probable that, these conditions being absent in the mode of cultivation on linen, the other common bacteria (micrococcus, bacterium, and various other common bacilli) find precedence.

The artificial cultivations in sterilized nourishing material have been achieved in several acute typical cases; in one, the comma bacilli that were present after 36 to 48 hours in large numbers on damp linen yielded the material for establishing cultures in test tubes; and also the flakes taken from the surface of the mucous membrane direct (within half an hour after death) introduced into test tubes yielded out of a large number of tubes several that proved to be pure cultures of the comma bacilli. In another case pure cultivations in test tubes were obtained in one out of a large number of tubes inoculated directly with a particle of the mucous membrane.

From these cultures a large number of second, third, fourth, fifth, and so on successive cultures were established, and the character of the comma bacilli when growing under various conditions could be accurately studied.

Now, it might be asked, does not this prove that the comma bacilli in pure cases of cholera are the typical inhabitants of the cavity of the intestine, whereas the presence of other putrefactive organisms is an accessory? The answer to this is: No; not at all. What it proves is this, that it is possible to obtain pure cultivations of the comma bacillus from the mucous membrane of the intestine; this necessitates the supposition that the particle used for inoculation was free of any but comma bacilli. But a number of culture tubes were obtained from the self-same intestine, in which there was a pure culture of a fine, short, straight bacillus. In these tubes, evidently, the particle used for inoculation contained the short, straight bacillus, respectively, but not the comma bacillus. With patience, and the methods used for the isolation of the different species of organisms cohabiting in fluids or solids, there is not very great difficulty in isolating any species of bacteria, be they micrococci, bacteria, bacilli, or anything else. (See Klein, "Micro-organisms and Disease.") And, as a matter of fact, pure cultivations have been in this way obtained of the bacterium termo, of the bacillus subtilis, and particularly of the fine, short, straight bacilli mentioned repeatedly as occurring in the rice-water stools. This was achieved after the method of Koch, viz, by diluting a particle of the mucous flake in a large quantity of nourishing material which at ordinary temperature is solid, but which can be liquefied by warmth. In this case agar-agar mixture (see below) was used, and after the particle of a mucous flake was diluted with one or two cubic centimeters of the sterilized and liquefied agar-agar mixture, this latter is poured out in a thin layer, in flat glass dishes, and allowed to solidify. The dishes are covered up with glass plates and kept in moist cells. After from 24 to 48 hours, or later, at a temperature of 75 to 85° F., various minute isolated specks are noticed in the glass dishes; each of these specks is a colony of generally one species of organisms; the different specks, if different organisms, show pecu-



liarities by which they can be distinguished already with the unaided eye. In this way the comma bacillus, the small straight bacillus, the bacterium termo, and other bacilli present in the fresh flakes, have been isolated.

Now, how do the comma bacilli behave when artificially cultivated outside the body? Do they exhibit characters by which they could be declared as different and specific from other bacteria, as is maintained by Koch (b. c.)? Besides the culture of comma bacilli of the intestinal flakes on damp linen, the cultivations have been carried out in test tubes in sterilized nutritive material of the same composition and after the same methods as mentioned in Klein, "Micro-organisms and Disease," chapter XI:

Agar-agar and Brand's meat extract and peptone, alkaline.

Agar-agar and peptone, alkaline.

Agar-agar and peptone, neutral.

Agar-agar and Brand's meat extract, neutral.

These materials were well sterilized and kept in sterilized test tubes, and plugged with sterilized cotton wool. The cultivations were carried on at ordinary temperature (about 80° F.), which proves quite sufficient for producing good crops already in 24 to 48 hours. All these materials are solid, and not liquefied by any of the bacteria that were cultivated.

The first and important result of the cultivations was this: Comma bacilli, micrococcus, bacterium termo, and lineola, bacillus subtilis, obtained from the alimentary canal, behaved in exactly the same way in these materials; all yielded good crops in alkaline as well as in neutral media, when grown at ordinary temperature, except that all of them yielded more copious crops in the alkaline than in the neutral medium, and the comma bacillus did not in this respect show any difference from other bacteria. The best cultivations of comma bacilli obtained were those made in neutral media, and, therefore, the statement of Koch, that the comma bacillus shows this specific character that it requires an alkaline nourishing medium—interpreted generally to mean that it does not live or grow well in any but alkaline media—is not borne out by these observations. Koch lays great stress on the detrimental influence of acid on the life and growth of the comma bacilli, and he uses this as an argument for his theory, that in healthy stomachs the comma bacilli are killed, and can not, therefore, pass in a living and active state into the small intestine.

Apart from the facts (1) that the comma bacilli in Koch's hands did actually grow and multiply on potato (of acid reaction), and (2) that a great many other organisms, such as bacterium termo, various micrococci and bacilli, both septic, zymogenic, and pathogenic, do not thrive in acid media, there is this important observation made in our cultures, that the comma bacilli did actually grow and multiply in fluid-nourishing media of a distinct acid reaction.

The comma bacilli obtained from flakes of choleraic ileum are not killed in media of weak acid reaction, for they live and, to a certain though limited extent, are also capable of multiplication in meat extract, peptone solution of distinctly though weak acid reaction.

As a second special character by which the growth of comma bacillus is said to be distinguished from other bacteria is the peculiarity in its mode of growth in gelatine. The description given by Koch of the peculiar appearances presented by the growth of the choleraic comma bacilli in nutritive gelatine is in all points correct. Koch states that in gelatine nourishing material the growth of the comma bacillus shows this peculiarity, that when growing at a spot it gradually enlarges, and, unlike other bacilli, assumes an irregular granulated or serrated outline. This character can not be, however, considered as in any way peculiar to the comma bacillus only, *since some other bacilli* behave in a similar manner, *i. e.*, when growing on a spot or patch, show an irregular outline, but, as will be presently mentioned, with rounded outline. The comma bacillus liquefies the gelatine, *so do other bacilli*, putrefactive and pathogenic ones motile and non-motile ones, *e. g.*, bacillus anthracis, various kinds of bacillus subtilis, Jequirity bacillus, a short straight bacillus of the mouth of healthy persons, bacterium termo.

Koch states that in gelatine nourishing material contained in test tubes the comma bacillus shown out at one spot on the surface of the material grows into the depth with a characteristic

funnel-shaped drawing inwards, liquefying at the same time the gelatine; but in connection with this, it must be remembered that almost each species of bacteria show certain peculiarities of growth by which an expert can distinguish them already with the unaided eye. Besides this the funnel-shaped drawing in of the surface by the growth is often absent, and moreover is also present in some growths of other organisms.

On agar-agar meat extract, peptone, the comma bacilli, when sown on the surface with the point of a needle or capillary tube, grow into transparent masses, with rounded or knobbed outlines and sometimes with radiating lines on the surface. If the bacilli are deposited at a point, this is seen to increase into a circular spot, gradually enlarging into a round patch; the center is thicker than the periphery, and hence a kind of central opacity is produced, *i. e.*, less transparency in the center than in the periphery.

A very interesting difference is noticeable between the comma bacilli carried on in neutral from those in alkaline media. In the former the bacilli, after from 4 to 6 days' growth, appear decidedly shorter, half the length of those carried on in the latter, their shape and curvature remaining distinct in both cases; some appear flat on one side, convex on the other. When growing in fluid which does not possess sufficient concentration, the comma bacilli, as was also seen by Koch, after a certain stage of multiplication is reached, undergo degeneration, becoming granular, and finally altogether die; they fade away and are lost to sight and do not take to stains. The living comma bacilli in cultivations are motile, single S-shaped, or even more complex, 3 or 4 remaining joined end to end, and they always move, owing to their peculiar shape, in a spiral; this, of course, is more pronounced in the S-shaped and complex ones than in the single examples.

Old cultures, some 6 or 7 weeks old, in neutral agar-agar show that the comma bacilli have a tendency to elongate, coiling and shriveling up at the same time, so that forms are met with which look like more or less distorted spirilla.

Koch states that the comma bacilli never form spores. The cultivation from flakes of the intestinal contents on damp linen, the cultivations of the comma bacilli in test tubes on alkaline solid material (agar-agar mixture) proved after 24 to 48 hours the existence of comma bacilli which differ from the typical ones in this respect, that they are about twice the thickness, some nearly flat on one side, convex on the other, and that they contained in their interior a spherical or slightly oval bright transparent droplet, which does not take the stain. In the short organisms there is only one about the center, in the long examples there may be 2 or even 3. And this appearance corresponds in certain respects to what is known of spores of other bacilli; in the well-known cases of spore formation (*Bacillus subtilis*, anthracis, etc.) the bacilli that form spores are known to swell up and to become thicker, and to form in the interior bright oval or spherical glistening spores which do not take the stain. And for spores these clear droplets could be easily mistaken, but further observations proved that this is altogether a different process, *i. e.*, vacuolation of the bacilli.

Now the objection might be urged, "but are the comma bacilli described and cultivated by Koch identical with those described and cultivated in this investigation?" It is not likely that such an objection will be raised by any one who has carefully read this and the description of Koch's, and compared the comma bacilli as figures here and in Koch's pamphlet; but seeing that a great many persons unacquainted or only imperfectly acquainted with investigations of this kind have asked innumerable unanswerable questions, and raised all kinds of objections to any criticisms unfavorable to Koch's view, it might be as well to answer such an objection. Well, first and foremost, the sources from which Koch obtained his comma bacilli were identical with the places from which we derived our comma bacilli, *viz.* acute typical cases of cholera; secondly, the locality from which Koch derived his comma bacilli, was identical with that from which we derive our comma bacilli, *viz.* the mucous flakes of the lower part of the ileum; thirdly, the morphological characters of Koch's comma bacilli are precisely the same as those of the comma bacilli described here; an inspection of Koch's illustration and ours, and a comparison of Koch's preparations with ours, leaves no doubt on this point; and lastly, the behavior of the comma bacilli grown on linen, on gelatine, and in other media is the same.



The examination of sections of the mesenteric glands, the kidney, liver, spleen, central nervous system, and the blood revealed no comma bacilli. One of the most remarkable facts observed is this: the mesenteric glands, in connection with the lower part of the ileum of several acute typical cases were examined carefully on fine microscopic sections, well stained with methyl blue, or gentian violet, or both, or Spiller's purple, and not a trace of comma bacillus could be detected in them, but not a single comma bacillus. If, as Koch maintains, the comma bacilli in these cases are present in the earliest stages of the disease, and even before, in great numbers in the mucous membrane of the ileum (the mucous membrane and the cavity of the ileum being as it were a pure cultivation), it becomes absolutely unintelligible that no comma bacilli should be absorbed and find their way into the mesenteric glands (for he assumes the presence of the comma bacilli and absorption of the chemical ferment introductory to the outbreak of the symptoms of the illness). It is against all that is known of pathogenic organisms; for one great character of them is to be able to exist in the living tissues, and the least one ought to expect to find is their immigration, absorption, and presence in the lymphatic tissues of the mesenteric glands. But, as a matter of fact, they are totally absent in these organs.

In the spleen there are certain microscopic lesions to be observed, consisting in death of patches of pulp tissue. These patches are irregular in outline and confluent; the healthy portions of the pulp become as it were permeated by dead tissue; probably this change is caused by stasis of the blood in the venous radicles of these parts. It shows itself in stained sections as unstained patches, the elements of the pulp being indistinct and not taking the stain.

Some of the arteries show hyaline degeneration of the inner coat, in consequence of which they become altogether occluded. In the kidney there is always opac swelling and granular degenerations of the epithelium of the convoluted urinary tubes; in the capillaries of the Malpighian tufts there is sometimes hemorrhage, always albuminous transudation into the cavity of the capsules of the Malpighian corpuscles; in the liver opac swelling of the liver cells and deposit of pigment in them.

In some of the lymph spaces granular matter may be met with taking the dye and on superficial examination may be mistaken for organisms, but their irregular shape and unequal sizes prove them to be different.

The mucous, and particularly the submucous, tissue of the intestine contain as a rule vast numbers of plasma cells, marked very conspicuously by their granules being stained conspicuously by the aniline dye, and generally of a different tint from the other tissues. Thus, in specimens stained with methyl blue and Spiller's purple, the granules in the plasma cells are stained pink; in specimens stained with gentian violet they are deep blue. The same plasma corpuscles occur in small numbers in the connective tissue of the kidney, particularly in that part forming the transition of the cortex into the medulla.

In the small intestine and in some villi, besides the total loosening and detachment of the epithelium of the surface of the Lieberkuhn crypts, there is always enormous congestion of the blood-vessels (stasis).

In the memorandum on the "Comma-shaped Bacillus," alleged to be the cause of cholera, Dr. T. R. Lewis, assistant professor of pathology, Army Medical School, at Netley, states that he examined sections of the small intestines of patients dead of cholera, in which no comma bacilli were present, and that also in the cholera evacuations the comma bacilli are sometimes extremely rare. From this he concludes Koch's statements as to the importance of the comma bacilli entirely upset. Dr. T. R. Lewis had not at that time before him Dr. Koch's detailed account, and for this reason his negative observation proves nothing against the theory of the comma bacilli. As has been quoted on a former page, Koch distinctly states that while comma bacilli are present in varying numbers in the evacuation of cholera patients, they can always be found in very great numbers in the mucous flakes of the lower part of the ileum, and that in acute typical cases of cholera the part of the mucosa of the ileum surrounding the lymph follicles is characteristically and generally infiltrated with them, so much so that the mucosa appears like a pure cultivation of comma bacilli, and that the further away from this part of the

ileum the less numerous they are to be met with. Now, large portions of the ileum can under statement be examined without finding any comma bacilli, or only a few of them; and nevertheless the mucous membrane of the lower part of the ileum might be full of them. Besides, as Koch states, only typical acute cases show the uncontaminated appearances. Such being the case, it is clear that Dr. T. R. Lewis's negative observation proves not much against Koch's theory, for Dr. Lewis does not state to have examined the lower part of the ileum in acute typical cases. He might have examined hundreds of sections of the upper part of the ileum or of the whole jejunum, without finding any comma bacilli. It happens that Koch is wrong with the lower part of the ileum (as has been minutely described on a former page), but that Koch's view might be right has not been disproved by those observations of Dr. T. R. Lewis. It is different with Dr. Lewis's statement of their occurrence in the mouth of healthy persons.

There is no doubt many not comma-shaped bacilli may, in dried and stained specimens, appear of a shape not unlike Koch's comma bacilli, *e. g.*, in every specimen of tubercle bacilli and glanders bacilli, and many others; one meets with individuals which are more or less curved, but that these are Koch's comma bacilli no experienced observer would dream of thinking. Koch justly insists on cultivating the comma bacilli of cholera patients, for only by artificial cultivations, *i. e.*, when large numbers of them become available, is it possible to be quite certain that one has to deal with a real and permanent form. Such being the case, the statement of Dr. T. R. Lewis that there occur in the saliva on dyed and stained specimens bacilli which look like Koch's comma bacilli does not yet prove that they are Koch's comma bacilli. What he ought to have done is to cultivate them, and hereby to ascertain whether this is a real and permanent form, and if he could have been able to show that they behave in cultivations exactly in the same manner as Koch's comma bacilli, then he would have been justified in drawing conclusions; but unfortunately he omitted to do so, and therefore his observations of bacilli which are curved although quite correct, nevertheless do not possess full critical value. The same applies to the observations of Drs. Finkler and Prior (note in No. 36 of the *Deutsche M., Woch.*, 1884), who have convinced themselves that in cholera nostras the evacuations contain comma bacilli morphologically identical with those found in Asiatic cholera. This of course does also away with Koch's statement of the diagnostic value of the comma bacilli for cholera. But of course it does not prove that the two kinds of comma bacilli are also physiologically identical.

Drs. Finkler and Prior have made certain statements as regards the life history of their comma bacilli, which are so much at variance with what is known of this and other organisms, that their conclusions were not received with great favor, but nevertheless the fact remains that they saw comma bacilli in cholera nostras, and that they have cultivated them. As has been stated afterwards by Koch these comma bacilli of Finkler and Prior differ in an unmistakable manner from the choleraic commas in gelatine cultures.

What has been stated just now applies to all other criticisms of Koch's comma bacillis, notably those by the French commission, as published in the "*Archive d'Anatomie and Physiologie.*" From all these criticisms this only is the positive result, that a comma bacillus is not of that diagnostic value as first thought by Koch, but whether it is connected or not with the disease of cholera is not proved one way or the other by all these observers, since they have not disproved, in fact have paid no attention whether or not in acute typical cases of cholera the lower part of the ileum, particularly the part of the mucosa surrounding the Peyer's and simple lymph gland is infiltrated with them, is as it were a pure cultivation of the comma bacilli.

Having thus far shown that some of Koch's statements as to relations of the comma bacillus to cholera are not borne out by the facts, it is now incumbent to show whether there occur in connection with cholera any organisms which, either in their distribution or in their general characters, could be reasonably associated with the cause of the disease.

The blood of cholera patients has been carefully examined in the fresh state on stained specimens and by cultivation. The blood was obtained according to the usual approved method from patients in various stages of the disease, from 10 hours after seizure to 48 hours, and in not one single instance could presence of any kind of bacterium or other organism be shown



to exist in the blood. The preparations examined fresh, those examined after staining with aniline dyes, revealed nothing that could be identified either as extraneous matter or as in any way indicating a special morphological change. All assertions to the contrary must be put down as based on imperfect method of examination or insufficient acquaintance with the appearances of blood in health and disease.

Messrs. Sicard, Taxies, and others, forming a commission appointed in France to investigate the mode of action of cholera, have put forward statements with regard to the behavior and morphological changes of the blood disks in cholera which appear wholly without foundation. In fact, we should like to place before this commission preparations of blood made of cholera patients within 10 hours, within 24 hours, and within 36 hours after the first symptoms of the disease set in, and at the same time preparations made of blood of perfectly healthy persons, and we challenge them to recognize the source of the preparations. That the virus of cholera is present in the blood, as maintained by these gentlemen, is an inference which has many probabilities (see a future page), but that its presence in the blood can be recognized by the examination of the morphological properties of the blood disks is a proposition the correctness of which we totally deny. Equally unreliable are their statements with regard to the production of cholera in rabbits by injecting into their vascular system the blood of cholera patients in the algid stage. Rabbits are for such experiments totally unsuited, since they so readily succumb to septic infection after injection into their veins of a variety of substances, occasionally only the operation of the vein is followed by septic infection. That the death of the rabbit was due to cholera, and not, as is more probable, to septic infection, remains to be proved.

What has been stated just now does not in any way oppose the statement of these French authors, that in the cholera the hæmoglobin of the blood disks becomes abstracted from the latter and destroyed; as a matter of fact the mucosa of the stomach, duodenum, and of the ileum (but in this latter to a much smaller extent), and particularly in the medulla of the mesenteric lymph glands, and in tubules of the medulla of the kidney, there are found conspicuous signs of a wholesale destruction of the blood corpuscles. In the muscularis mucosæ, and to a lesser degree in the muscularis externa, of the stomach and particularly of the duodenum, there occurs an extensive deposit in the muscular tissue of the blood pigment in the shape of fine brown granules, spherical droplets, and plates, so much so that all the muscular cells are beautifully marked as brown granular spindles.

In the medulla of the mesenteric lymph glands the lymphatic tissues contain vast numbers of brownish particles of an oval or spherical shape, and of various sizes, from that of a minute granule to that of the size of a blood disk and larger.

Nor did the examination of the tissue of the liver, kidney, mesenteric glands and spleen, the medulla oblongata, and muscle reveal the presence of any kind of specific bacteria, except in a few instances, when in the portal vessels a few bactilli of clearly putrefactive origin could be detected.

Numerous cultivations were made with the juice of the mesenteric glands, but no trace of bacteria was obtained, except in those cases tubes in which clearly and unmistakably putrefactive micrococci or putrefactive thickish bacilli had found their entrance. Thus then as regards the blood and tissues the conclusion is imperative that no kind of bacteria are present in patients suffering from cholera.

In the small intestine, and particularly about the ileo-cæcal valve, one finds in acute cases dissected immediately or soon after death freely floating glassy looking clumps of mucous, which slightly differ from the ordinary epithelial flakes detached from the surface of the mucous membrane or floating in the clear fluid. They resemble clumps more than flakes and are more transparent; when examined under the microscope they prove to consist chiefly of mucous or lymph corpuscles, and of a few epithelial cells embedded in a hyaline mucous matter, but the same lymph corpuscles may occur also, only not so numerous, in the ordinary flakes. These lymph corpuscles are always numerous present in those peculiar clumps, provided the examination is made very soon after death. After an hour and a half or two hours one

misses them, since they easily become macerated and disintegrated in the intestinal fluid. They can be found also among the flakes of the rice-water stools, provided they are quite fresh, but then they are often obtained only in a fragmentary state; but the sooner the post-mortem is made the more numerous they are found in those glassy clumps. Lewis and Cunningham in their reports on cholera noticed them, and they correctly state that in order to see them the material must be fresh, *i. e.*, examined very soon after death. One misses their mention in Koch's paper altogether, be it that his attention was chiefly or wholly directed to the comma bacilli, or, what seems more probable, his dissections were not made sufficiently soon after death. That this is the more likely explanation appears from the fact that when stained with aniline dyes many of these corpuscles contain some interesting things, as will appear presently, and had those corpuscles been present in Koch's specimens he could not have failed to notice their contents. If he had noticed them the probabilities are that he would have abandoned the comma bacilli, since the contents of these mucous corpuscles are the only definite things that exist as regards bacteria, and they have a much more intimate relation to a tissue than the comma bacilli. Examining these mucous corpuscles in preparations dried (after the Weigert-Koch method, in thin layers) and stained with gentian violet, or Spiller's purple, or methyl blue, they present themselves as spherical, oval, or irregular corpuscles of about the diameter of ordinary white blood corpuscles, or larger if swollen up. Each contains two or three deeply tinted oval, spherical, or angular nuclei. Their protoplasm is more or less hyaline, and they vary in size, inasmuch as many of them show signs of being swollen up or even in the act of disintegration, as is indicated by their faint or broken outline respectively. The best preserved spherical corpuscles are completely filled with a very minute straight bacilli. Those that are slightly swollen show the bacilli more isolated, but still in many places in groups, and in those that are much swollen up and at the point of disintegration the bacilli are seen very loosely and irregularly scattered through the protoplasm, or on the point of leaving the corpuscle altogether. The accompanying figures 4 and 5 illustrate all these points. In the neighborhood one always meets with the same minute bacilli scattered about. The appearances presented by these mucous corpuscles filled with the bacilli, and of those that have swollen up and in which the bacilli are loosely scattered through them, are extremely striking, since the bacilli are stained deeply, whereas the cell substance appears homogeneous. Of course it is necessary to obtain these mucous corpuscles in a well-preserved state, and for this reason they can be seen best in acute cases, where the dissection is made immediately after death. In stools, owing to the rapidity with which these corpuscles disintegrate, they are generally missed. And this is very probably the reason why Koch missed them, and for this reason it is justifiable to assume that Koch did not make his dissections sufficiently soon after death, a fact which has an important bearing on understanding his statement as to the presence of comma bacilli and other bacilli in the mucous membrane itself. These lymph corpuscles are always to be met with in the glassy clumps and under the conditions mentioned above, but not in all instances does one find that they contain the same abundance of the small bacilli, for in some cases these latter were missed in most of the well-preserved corpuscles, and found only in those that had slightly swollen up or were on the point of disintegration, but in all instances the same small bacilli are found scattered in amongst the detached epithelial and lymph cells. There has not been a single case examined in which they were not found in the mucous flakes, in cases in which the comma bacilli were very scarce, the small bacilli were not scarcer. In most cases they were met in larger or smaller groups and as isolated examples.

(As one amongst several interesting cases as regards the occurrence both of comma bacilli and the small straight bacilli is the following: E., aged 25, had been purging and vomiting since 12 o'clock in the night of November 15th; was admitted into Medical College Hospital, Calcutta, on 16th November, at 10 a. m., under symptoms typical of acute stage of cholera. Died at 1.45 p. m., *i. e.*, a little over 25 hours after attack. Post-mortem at 2.20 p. m. Ileum contains clear watery fluid, with glassy mucous flakes. In the mucous membrane a few minute hæmorrhagic spots not bigger than the point of a pin; Peyer's glands not visible. In



the mucous flakes were large numbers of lymph corpuscles, some perfect and small, others swollen up; many of them contain the small straight bacilli in great numbers; besides this there were numerous large masses entirely composed of the small bacilli, but also comma bacilli were everywhere to be found, although the small bacilli were in the majority. Cultivations made on linen from these mucous flakes yielded after 24 hours large crops both of comma bacilla and of the small straight bacilli).

These bacilli are of extremely small size, about half to two-thirds of the comma bacilli and about one-third or one-fourth their length. They are straight and appear pointed at each end; generally they are single, but also occasionally they form a chain of two elements. In the well preserved mucous corpuscles they lie closely packed together, apparently all single; in the large swollen corpuscles there are some in couples; and amongst those one meets free around and between the lymph corpuscles and epithelial cells there are a good many in couples and in small groups. It is not at all of rare occurrence to meet with mucous flakes of rice-water stools in which the corpuscles were found almost completely disintegrated; there were nevertheless found many groups of small bacilli, from six to twenty.

Two questions present themselves in connection with these lymph corpuscles: (1) where do they come from? and (2) where do they get the bacilli from? There can be no difficulty in answering the first. It is well known that in all these places, where the highly vascular lymphatic tissue reaches the free epithelium of a mucous membrane, *e. g.*, the tonsils of the palate and pharynx, the lymph follicles of the pyloric end of the stomach and the duodenal part of the intestine, the solitary and animated lymph follicles of the ileum, and those of the Peyer's gland of the lower part of the ileum and ileo-cæcal valve, lymph corpuscles pass (migrate) easily through the surface epithelium and are discharged onto the free surface. This is the case already in the normal condition to a certain extent, and to a greater extent in the pathological state.

The mucous corpuscles found in the mouth are those that have passed out from the superficial lymphatic tissue of the tonsils. In the Peyer's glands of the ileum one constantly meets these same corpuscles on their way through the surface epithelium.

The second question is more difficult to answer. From the fact that the bacilli are found outside and inside the mucous corpuscles it might be said that the mucous corpuscles being endowed with amoeboid movement while and immediately after passing out of the mucosa, are probably capable of swallowing the bacilli just as lymph corpuscles are capable of swallowing other granular matter; but against this might be urged that the mucous corpuscles, having passed out of the mucosa, probably do not long retain their amoeboid power; proof, the rapidity with which they swell up and disintegrate in the watery contents of the intestine. The fact that the better the corpuscles are preserved the more numerous the bacilli, might be an argument either way, and besides, several cases have been examined with this view and only in one was the bacilli found plentiful within the well-preserved corpuscles; they were absent, or almost absent, in the well-preserved corpuscles of other cases, but were present in small numbers in those that had already swollen up or commenced to disintegrate. There is one other point which must be mentioned in connection with this—it is the fact that, although these bacilli are not endowed with locomotion, it is not impossible that they settle on these corpuscles and penetrate by active growth into them, finding in their protoplasm a good soil.

A very careful examination of fine microscopic sections of different parts of the intestine well-preserved and well stained in the different aniline dyes was made in order to trace, if possible, these small bacilli isolated or inclosed in cells, from the lymphatic tissues of the mucous membranes outwards, but all in vain. No trace of them could be found in the lymph corpuscles or any other part of the mucous membrane, neither in the stomach, intestine, mesenteric glands, blood, or any matter tissue.

On the whole, then, although these bacilli looked very promising at first as regards their connection with the disease, they had nevertheless to be abandoned, and had to be regarded, like the comma bacilli, as something extraneous, present only in tissues practically dead in the cavity of the alimentary canal. But if any one wishes to urge that these small bacilli are

probably connected with the disease, there would exist for such a view at least as much, if not more, justification than for Koch's comma bacillus, since these small bacilli are found in some elements derived from the tissue of the intestine; the comma bacilli are not, and are always present in the mucous flakes and in the intestinal contents as often, and as numerous as the comma bacilli, at any rate in acute cases, and post mortem examination being made soon. In the watery vomit, when copious, of acute cases these small bacilli are generally not missed, chiefly as isolated individuals or in small groups.

And in the same way, if not more so, we might further urge that they are quite capable of forming some kind of chemical ferment, which, when absorbed, produces the disease. All this could be said with the same justification of these small bacilli as Koch has done of the comma bacilli, and such a theory would rest on a basis not a bit weaker than the one on which Koch's theory of the comma bacillus rests. Any one who feels satisfied with such evidence is quite welcome to use it.

These small bacilli have been cultivated by one of us in the same way as have the comma bacilli on linen kept moist by filter-paper under a bell glass, on mixtures of agar agar, meat extract, and peptone, alkaline and neutral, and their characters have thus been studied. They grow well at ordinary temperature (75 to 82 degrees F.), so that already after 24 to 48 hours considerable masses become available; of course they grow much more rapidly at higher temperatures (90 to 102 degrees F.), and they grow like the comma bacilli and other bacilli much better and more copiously in alkaline than in neutral media.

The appearances presented after inoculation of the material in test-tubes is very much like that presented by the comma bacilli; from the point of inoculation the growth spreads in the form of a flattened or filmy rounded whitish mass, its outlines uneven or knobby. Growing on linen and on agar agar mixtures (solid), the bacilli are seen singly or very often in chains of two or dumb-bells, the single bacilli are of the same small size as those mentioned above, but many of them grow to somewhat greater length in the cultivation than in the fresh material. After 24 to 48 hours' growth some of them begin to show the formation of spore in the shape of a bright glistening spherical granule, the substance of the bacillus gradually becoming pale, not staining, and ultimately altogether fading away, so that all the spore is left. After several days' growth many of the bacilli, which have not formed spores, become pale, stain very faintly, and gradually fade altogether away. This change, indicating the degeneration and death of the bacilli, differs in no way from what was observed of the comma bacilli and described on a former page. Growing in gelatine they do not liquefy the material and form clumps of a whitish appearance.

When in Egypt and Calcutta, Koch performed a large number of experiments by feeding subcutaneous and intravenous injection, as well as injection into the duodenum, with rice-water stools, and with pure cultivation of comma bacilla on rodents, carnivorous animals, and monkeys, and obtained no result, and his inquiries among the people led him to the conclusion that no case was known of a domestic animal having taken cholera, and he therefore came to the conclusion that cholera is not transmissible to the lower animals. He made, however, the observation that animals (rodents) may die of septicæmia after inoculation with rice-water stools, and that the comma bacilli are capable of multiplication within the animals inoculated, without, however, producing cholera. Since his return to Berlin he maintained that he has been able to confirm the assertions of Nicati and Rietsch, viz., that injection of the comma bacilli into the duodenum of dogs and guinea pigs led to death with multiplication of the comma bacilli, and he therefore considers it proved that the comma bacilli are pathogenic organisms.

A large number of experiments were performed by one of us on rodents, cats, dogs, and monkeys by feeding, by subcutaneous, intraperitoneal, and intravenous injection, and by injection into the cavity of the upper part of the small intestine of mucous flakes of the ileum of typical acute cholera, and of pure cultivations of choleraic comma bacilli and the small straight comma bacilli; the results of these experiments are described in the following pages.



## EXPERIMENTS ON ANIMALS WITH CHOLERAIC EVACUATIONS AND CULTIVATIONS OF ITS BACTERIA.

Various experimenters have tried to communicate cholera to the lower animals, but without success. Thiersch, Sanderson, and others thought to have succeeded in white mice by feeding them on bits of paper steeped in choleraic evacuations, but it was pointed out by Ranke that similar results are obtainable by feeding them on paper that had not been so steeped.

Koch has made a large number of experiments, both by feeding on and inoculation with choleraic evacuations and with pure cultivations of comma bacilli of cats, dogs, monkeys, mice, guinea-pigs, rabbits, and rats, under the most varied conditions, but without positive results. When a disease is produced in guinea-pigs, rabbits, and mice it is not cholera but septicæmia, and Koch made the important observation that in mice the animals inoculated with the comma bacilli die sometimes of septicæmia but not of cholera, and show then comma bacilli in the blood.

Another important observation of Koch is the one according to which the comma bacilli are capable of *multiplication when introduced directly into the small intestine, but without producing cholera.*

It seems clear from these observations of Koch that the comma bacilli can propagate themselves and thrive well in the bowels, and even in the blood, but without producing cholera. In connection with this it is important to notice that there have been made several similar observations with regard to other putrefactive bacteria (*vide* the bacilli of papayin solution, the bacilli in jequirity infusion). In the experiments of Professor Rossbach (Centralbl. f. d., medizin, Wiss., 5, 1882), injection of a solution of papayotin into the veins of rabbits is followed by death of the animals. The blood teems with the bacilli; these bacilli are derived from spores that had been present in the solution of papayotin. But death of the animals is produced in exactly the same way if those spores are, previous to the injection, removed by filtration (Dowdeswell, Practitioner, 1883). Consequently those bacilli have nothing to do with the disease and death of the animals. Their development is due to the blood being transformed by the papayotin poison into a medium suitable for the development and growth of these bacilli.

In the same way an unfiltered jequirity solution contains the spores of bacillus subtilis, and, if poisoning is produced by injection of such a solution, the tissue and the blood may become a suitable soil for the growth and multiplication of these bacilli (Salomonsen). But the disease and death of the animals have nothing to do with these bacilli, since a perfectly sterilized jequirity infusion produces disease and death in precisely the same manner as one that has not previously been deprived of these spores.

The experiments performed by Dr. Richards on a pig have been fully considered by Koch, and the conclusion becomes inevitable that the cause of death in the pig was due to a toxic principle present in the choleraic evacuations, similar to what is known to be the case in typhoid and other evacuations.

A very curious illustration of how easily investigators are led into error is furnished by the description given by Nicati and Rietsch (as quoted in the "Fortschritte der Med." Heft. 19, Beilage, copied from "Semaine Medicale," p. 370) of experiments on dogs, in whom the chief bile duct had been ligatured before introduction into their intestines of choleraic evacuations or pure cultures of Koch's comma bacilli. These dogs were said to die after one or two days with choleraic symptoms. The intestinal contents were a creamy fluid (see below) with many detached epithelial cells. In these contents the comma bacilli were found in great numbers.

If these observers had ligatured the chief bile duct in many dogs, they would have found in some cases death to occur in the same way and the intestine filled with the same creamy contents. If, now, a loop of this intestine had been cut out, and comma bacilli had been introduced into it, the comma bacilli would have found herein a good soil wherein to multiply.

And such experiments are seriously put forward as proving that cholera is transmissible to animals, and that the comma bacilli are the *materies morbi*, because they had been found capable of multiplication in the cavity of the intestine. It would have been very surprising if, under such conditions as the above, the comma bacilli had not multiplied, because the intestine was made diseased, and the comma bacilli grow well in the intestinal contents, mucus and detached epithelium.

Dr. C. Friedlander (*ibidem*), who seems to be very enthusiastic about these experiments, shows a singular want of judgment in thinking that, because in cases of fully developed cholera the intestinal contents and evacuations are free of bile, therefore a necessary condition for the success of the experiments in animals is the exclusion of bile, *i. e.*, the ligaturing of the chief bile duct as done by the French experimenters. With equal justice he might argue that because in cholera there is suppression of urine therefore a necessary condition for the success of the experiment is the ligaturing of the ureters. How many cases of cholera has Dr. Friedlander seen? Have not all, before the disease actually set in, *i. e.*, during incubation, shown colored faeces? The absurdity of such an argument is self-evident. But the want of judgment in the French experimenters, and perhaps still more so in their critic, Dr. C. Friedlander, becomes quite inexplicable if in the same article we read that the experiment with the comma bacilli succeeded equally well in guinea-pigs, in whose stomach and intestine the comma bacilli had been introduced without previous ligature of the bile ducts. The animals by which by opening the peritoneum the intestine had thus been operated upon died from "choleraic" symptoms.

Koch having ascertained (a) that cholera is by no means transmissible to the lower animals, (b) that if the animals (mice, rabbits, guinea-pigs) die it is from septicæmia and not cholera, and (c) that the comma bacilli are capable of multiplication within the intestine of animals without producing cholera, it must seem most astounding to all who have followed his statements to find that Koch suddenly (*Deutsche Med., Woch., No. 45, 1884*) asserts that he has been able to convince himself that cholera is transmissible to animals.

Encouraged by the experiments of Nicati and Reitsch, he has injected into the small intestine of several dogs, but without ligaturing the bile duct, small quantities of pure cultivation of comma bacilli, and found that with few exceptions the animals died between from one and one-half to three days, the small intestine was reddened, and its cavity contained a watery fluid; the comma bacilli injected had greatly multiplied. Koch does not state under what symptoms the animals died. It is to be assumed that if they had shown symptoms of cholera Koch would not have omitted to state it, but not saying they evidently did not show any of those symptoms which indicate cholera, *i. e.*, vomiting, purging with rice-water stools, cramps, great fall of temperature, and suppression of urine.

The two statements of Koch, viz, the first in his full report and the second recently made, as to the production of cholera by comma bacilli in animals, are in direct opposition, and it is quite impossible to reconcile them.

There seems, however, one way to explain this remarkable change of Koch's, and it seems this: v. Pettenkofer challenged Koch to supply him with pure cultivations of the comma bacilli, as he (Pettenkofer) with other medical men in Munich are quite ready to swallow any quantity of them. Koch could not easily leave such a challenge unanswered, and it was, therefore, very urgent to show that such an experiment would be unnecessary since the pathogenic properties of the comma bacilli can be tested on animals.

Dr. Van Ermengen (*Berliner Klin., Woch., December, 1884*), while confirming Koch as to the distribution of the comma bacilli and their mode of growth, was also successful in producing death in animals inoculated with the comma bacilli. That these animals should have died from septic infection or in consequence of the operation does not seem to have occurred to any of these observers. This might have easily have been thought of; the operation of getting at the duodenum after the opening of the peritoneal cavity is not a light one, and in addition these experiments were not done thoroughly antiseptically. To crown all this, no control experiments whatever seem to have been performed. If they made them, *i. e.*, if they had opened the perito-



neal cavity of dogs, and still more of rodents, without antiseptic precautions, and if they had then pulled out the duodenum, an operation always involving a considerable amount of mechanical injury to the intestine, and if they had omitted altogether to inject the comma bacilli, they would have obtained death of many of the animals owing to septic poisoning or in consequence of the mechanical injury. The diarrhea and intestinal disease, present after such an operation, obviously can not be placed to the account of the comma bacilli, since the same symptom is observed in a very large percentage of cases of pure septic poisoning.

A number of experiments were performed on monkeys, cats, mice, rats, and rabbits.

The results are these :

- (1) Two monkeys fed\* with rice-water stool abounding in comma bacilli on the same day that the stool was passed, and again after having been kept for 24 hours. No result.
- (2) Fed the same two monkeys with pure cultivation of comma bacilli. No result.
- (3) Fed the same two monkeys with cultivation of comma bacilli on linen. No result.
- (4) Fed four fresh monkeys with rice-water stool mixed with milk after having been kept spread out on bread for 24 hours. No result.
- (5) Fed the same four monkeys with rice-water stool mixed with milk after having been kept spread out on bread for 48 hours. No result.
- (6) Fed the same monkeys with watery choleraic vomit mixed with milk after having been kept spread out on bread for 24 hours. No result.
- (7) Two cats were fed with fresh rice-water stool. No result.
- (8) The same two cats were fed with rice-water stool kept for 24 hours. No result.
- (9) Fed two fresh cats with rice-water stool mixed with milk and bread after having been kept for 24 hours. No result. (One of the cats was found dying 16 days after. The animal had fallen off its food during the last four or five days, but otherwise had shown no symptoms. On post-mortem the stomach and intestines were found perfectly normal, so was the liver, spleen, lungs, and blood; both kidneys were enlarged, white, and fatty degenerated).
- (10) With rice-water stool kept for 24 hours and then mixed with milk and bread fed four white mice, 1, 2, 3, 4. Fed them again with the same stool having been kept further 24 hours.

Mice Nos. 1 and 2 were found dead the second day after the second feeding. No symptoms observable during life. On post-mortem examination it was found that the small intestine was distended with mucus, lungs were found inflamed; no other change. The microscopic examination of the heart's blood revealed the presence of numerous longish straight bacilli. The contents of the small intestines showed, besides epithelial cells in various stages of disintegration, large numbers of longish straight bacilli (*b. subtilis*), many of them with spores and numerous micrococci. No comma bacilli of any kind. Mouse No. 3 was found dead on the fourth day. Lungs were much inflamed, small intestines distended with creamy fluid; this fluid contained numbers of epithelial cells and whole groups of epithelial tubes, evidently the lining of Lieberkuhn's crypts, and besides straight bacilli (*bac. subtilis*) large numbers of beautiful comma-shaped bacilli of at least two (possibly three) varieties, differing from one another very markedly in length and thickness. They were isolated or in couples and S-shaped; they were markedly pointed at their extremities.

The smaller variety were a little larger than the comma bacilli of cholera stools, but were conspicuous and different by their very tapering and pointed ends. The blood of the heart contained various kinds of straight bacilli, and a fair number of comma bacilli of the same different varieties as those in the intestinal mucus.

Such a condition, namely, lungs inflamed, intestines inflamed and distended by creamy mucus, is a condition familiar to every one who has seen many cases of septicæmia both in mice and rabbits occurring after experiment, and in not by any means rare instances spontaneously. To consider the death of the above mice as due to cholera and their post-mortem appearances as indicating cholera would be absolutely unwarranted. It so happened that at the same time two mice died that had not been subject to any experiment, having been kept

\* All "feeding" was done on an empty stomach.

altogether separately. One interesting fact resulted from these experiments. It is this, that comma bacilli of different varieties and different from the human comma were found in the intestinal mucus and in the blood of an animal that could not be said to have been affected with cholera.

EXPERIMENTS MADE WITH INTESTINAL MUCUS AND WITH BLOOD OF THESE THREE MICE,  
NOS. 1, 2, AND 3.

(a) Mixed intestinal mucus (fresh) of mouse 1 with milk and bread, and fed with it two mice (11 and 12) and two rats (5 and 6).

In the same way fed with intestinal mucus of mouse 3 two mice (17 and 18) and two rats (7 and 8).

The mouse 11 was found dead three days thereafter; there was no distinct anatomical change in any organ.

The mouse 12 was found dead four days after; small intestine was distended with creamy mucus; no comma bacilli in it of any kind, only small and largish straight bacilli. Lungs inflamed. Blood of heart contains bacilli, differing in thickness and length.

All rats (5, 6, 7, 8) remained well, mice 17 and 18 remained well.

It follows then, from these experiments, that mice 11 and 12, fed with intestinal mucus of mouse 1 and not containing any comma bacilli, died; whereas the mice 17 and 18 fed with the intestinal mucus of mouse 3, *i. e.*, the one containing numbers of comma bacilli, remained perfectly well.

That the mice 11 and 12 died in consequence of the feeding can not be proved; the symptoms were more like those of some kind of septicæmia.

(b) Diluted heart's blood of mouse 3 with neutral saline solution, and inoculated with it subcutaneously two mice, 13 and 14, and two rats, 15 and 16.

(This blood contained numerous comma bacilli of at least two varieties.) Both mice 13 and 14 were dead four days afterwards.

Showed no symptoms during life. On post-mortem examination lungs were found inflamed, small intestine distended with mucus; heart's blood contained large numbers of minute vibrios, but quite unlike the comma bacilli of mouse 3.

The vibrios look more like imperfect spirilla. Many of the vibrios contained one or more granules. Besides these there were present thickish and thin straight bacilli.

The intestinal mucus contained various kinds of straight bacilli, differing in length and thickness.

(c) The blood of mouse 12 was diluted with neutral saline solution, and inoculated with it subcutaneously two mice (19 and 20), and two rats (21 and 22). One of these was found dead 3 hours after, lungs much inflamed; the other was dying 24 hours after. In the heart's blood were a few thickish bacilli; slight congestion of the intestine; lungs inflamed.

It follows from that the death of these mice could not have been caused by the inoculation, since only a drop of the diluted blood was used for inoculation and the state of the lungs in both animals was clearly of older standing than the inoculation.

The two rats remained well.

From these experiments it follows that the mice died under anatomical lesions, indicating some kind of septicæmia, and that death could not have been either the result of feeding or inoculation, since other mice died with the same lesions, but which had not been the subject of experiment.

The death of mouse 19 proves this beyond doubt, since it died with the same symptoms, and must have been suffering from the disease before inoculation was performed.

In some of the animals the small intestine was distended with a creamy fluid containing numerous detached epithelial cells and various kinds of bacilli.

It is important to take notice of this fact since there appears, judging from the statements of various French observers, a tendency to consider such an occurrence in animals experimented upon with choleraic material as indicating that the animal had died of cholera. Nothing would be more unjustified.



INOCULATION EXPERIMENTS MADE WITH CULTIVATIONS OF COMMA BACILLI AND THE SMALL STRAIGHT BACILLI.

(a) With a pure cultivation of comma bacilli started from mucous flakes of an acute typical case inoculated two rabbits into the subcutaneous tissue of the thigh. No result.

(b) With the same cultivation inoculated to rabbits into the peritoneal cavity. No result.

(c) With the same cultivation injected into the jugular vein of two rabbits. No result.

(d) A hypodermic syringe filled from this cultivation injected into the small intestine of one rabbit. No result. On dissection being made before the end of a week, all organs were found perfectly healthy. In the intestine no trace of any change, no comma bacilli.

(e) With a cultivation on linen of comma bacilli and the small bacilli, 24 hours old, inoculated two rabbits subcutaneously. No result.

(f) With same material inoculated two rabbits into the peritoneal cavity. No result. (One of these rabbits died on the eighth day with severe peritonitis, much peritoneal exudation and lymph. No comma bacilli or other organisms in the exudations or blood.)

(g) With the same cultivation inoculated one rabbit into jugular vein. This animal was rather in a poor condition, having had an abscess on the back, due to caries of a dorsal vertebra. The animal died on the seventh day with severe peritonitis and pleuritis, copious sanguineous exudation, inflammation of the lungs; no comma bacilli or any other organisms in blood and exudation.

(h) Of a mixture of a cultivation of comma bacilli with a cultivation of small bacilli inoculated (injected one hypodermic syringe full) into the cavity of the small intestine of one small monkey. No result.

(i) Of same cultivation, injected about one-half syringe full into the jugular vein of another small monkey. No result.

(j) Mucus flakes and fluid taken from the ileum of an acute typical case had been kept in a capsule for three days; after this time there were present in the fluid large numbers of putrefactive organisms, large bacilli and micrococci, in some of the flakes comma bacilli were present in enormous numbers; besides these there were numerous S-shaped and spirillum organisms which could be distinctly seen to be derived from the comma bacilli (see fig. 13). Of the flakes full of commas injected one syringe full into the cavity of the small intestine of one cat. No result.

(k) Of same material injected one syringe full into the jugular vein of another cat. No result.

(l) Of a mixture of a cultivation of comma bacilli and of small bacilli injected one syringe full into the cavity of the small intestine of one (third) small monkey. No result.

(m) Of same cultivations injected half a syringe full into the jugular vein of one (fourth) small monkey. No result.

(n) Of same material injected one syringe full into the duodenum of a rabbit. No result.

(o) Ditto one rabbit into small intestine. No result.

(p) Ditto one rabbit into jugular vein. No result.

From all these experiments it follows that neither with mucus flakes taken from the ileum of acute cases of cholera, nor with stools recent and old, nor with cultivations of comma bacilli, is it possible to produce in animals (mice, rats, cats, rabbits, and monkeys) any illness, be the introduction into the system carried out by feeding, by subcutaneous injection into the jugular vein, or by injection into the cavity of the intestine.

That the animals operated on by Nicati and Rietsch, and by Koch and others (mentioned on a previous page), did not die of cholera, but in consequence of the operation, must be evident to every one who has much experimented in Europe.

While cats readily get over abdominal operations, dogs do not do so, besides the fact that in the case of cats and monkeys, although considerable quantities of mucus full of comma bacilli and pure cultivations of comma bacilli were injected into the bowels, the animals did not die, and showed no symptoms, proves that the choleraic comma bacilli are quite harmless

on these animals; and if any animal would be likely to take cholera it would be monkeys; nor is it likely that there should exist such a vast difference in susceptibility between cats and dogs.

(Koch seems to think that the injection must be made into the duodenum, but how is this reconcilable with his statement that the disease has its seat chiefly in the lower part of the ileum?)

It is well known that in India even severe surgical operations succeed much easier than in Europe, and this presumably applies also to animals; such severe operations as abdominal operations (opening the peritoneum and drawing out a loop of intestine) succeed readily, as has been shown, in India, on rabbits, cats, and monkeys, but the experiments have been repeated in Calcutta on dogs with the same negative result.

In two dogs, the peritoneum was opened on the linea alba, and a considerable quantity of pure cultivation of comma bacilli, derived from the mucus flakes of a cholera ileum, was injected in the duodenum; in a third dog only water was injected; all the seanimals remained alive and showed absolutely no symptoms. From these experiments it follows, (1) that the animals operated upon by Nicati and Rietsch and by Koch did not die of cholera, but in consequence of the operation, and (2) that neither the comma bacilli of cultivation nor those in the original mucus flakes of choleraic intestine are capable of producing cholera when injected into the small intestine of rabbits, cats, monkeys, or dogs.

*Addendum.*—Professor Horsley, of the Brown Institution, London, has made for Mr. G. Dowdeswell similar experiments on four rabbits, two guinea-pigs, and one dog, with pure cultivations of choleraic comma bacilli (derived from cholera cases in France as well as from India); a small quantity was injected into the upper part of the small intestine. *The operation was made antiseptically. All seven animals remained well.* Professor Horsley has also kindly made for one of us the following experiments on guinea-pigs and dogs:

Three dogs were operated upon antiseptically; of pure cultivation of living and fresh choleraic comma bacilli in gelatine, half a hypodermic syringe full was injected into the commencement of the duodenum of each animal. No result.

In a further series 5 dogs were similarly operated upon, and the comma bacilli were injected into the duodenum, but no result followed.

Three guinea-pigs were operated upon, *not antiseptically*, of a cultivation of bacillus grown in gelatine and derived originally some 15 months ago from a jequirity infusion—but passed through several successive cultivations in broth and proved to be quite innocuous—less than half a hypodermic syringe was injected into the commencement of the duodenum of each animal.

All these animals were dead before 3 days were over. The small intestine was much congested, its cavity was filled with mucus containing large masses of detached epithelium cells.

It must be clear from these experiments that the choleraic comma bacilli injected into the intestine of rodents or carnivorous animals in London have neither the power of producing cholera, nor have they the power of producing any diseased condition, and therefore are not pathogenic organisms.

The assumption that the comma bacilli introduced into the small intestines of animals are capable of multiplication, and of producing a special poison which, absorbed into the system, produces death, is not borne out by these experiments. The fact observed by Koch and others that the comma bacilli are capable of multiplying and growing in the cavity of the alimentary canal does not prove any thing for their assumed pathogenic property, since they would naturally be capable of growing in that locality, which is their natural breeding ground. The deaths of the animals, then, operated upon by Koch and others, is not due to any specific disease-producing power of the comma bacilli, but is due to septic infection or in consequence of the operation. The operation alone, exposure of the peritoneal cavity, the handling of the duodenum not performed under spray—leaving out any subsequent injection of the comma bacilli—produces death with the same symptoms as in the experiments of Koch and others. That the comma bacilli, like other putrefactive bacteria, are capable of producing the septic poison (ptomaines) seem to appear from the later experiments of Nicat and Rietsch, who



injected comparatively large doses of broth in which the comma bacilli had been growing, and from which, subsequently, the comma bacilli were removed by filtration. The symptoms under which the animals died were identical with those of septic intoxication, such as are produced by the injection of putrid fluids from which the putrefactive bacteria had been previously removed. Nicat and Rietsch seem to be, strange to say, altogether unacquainted with the observations of Gaspard, Panum, Bergmann, Weber, Billroth, and many others who have studied and described the pathology of septic infection in dogs; the two French experimenters consider, stranger still, their own result as indicating the production by the comma bacilli of a specific virus. It should be said that the experiments performed by Koch, Nicat, and Rietsch, if they do not prove that cholera is transmissible to animals, at any rate prove that the choleraic comma bacilli are capable of growing in the mucous membrane of the small intestine of animals and then to produce a chemical poison, hence are pathogenic. The answer to this would be this: Amongst the innumerable bacteria existing in normal human faecal matter, there is one species of minute bacilli which Bienstock has succeeded in isolating by artificial cultivation in alkaline solid media. These bacilli inoculated into mice produce death in 24 hours, bacilli being found in the blood of the animals (*Centranbl. f. d. Med. Wiss.*, 1883, p. 949); and further, Pasteur and Sternberg have isolated from the normal human saliva a species of bacterium which produces fatal disease in rabbits.

In conclusion, we wish to render our best thanks to the following gentlemen, who, during our stay in India, have generously and liberally given us every possible assistance, and have secured to us every facility for carrying out our investigations: Dr. Cunningham, sanitary commissioner with the Government of India; Dr. Barclay, secretary to the sanitary commissioner; Dr. Hewlett, deputy surgeon-general with the Government of Bombay; Dr. Cook, principal of the Grant Medical College in Bombay; Dr. Waters, pathologist in the same college; Dr. Lyon, professor of chemistry in the same college; Dr. Anna, physician in the cholera ward of the same college; Dr. Coates, principal of the medical college in Calcutta; Dr. Waddell, professor of chemistry in the same college; Dr. C. Mackenzie; and last, but not least, Dr. D. D. Cunningham, professor of physiology in the medical college in Calcutta.

To Mr. Alfred Lingard, who has rendered most valuable assistance in every part of the inquiry, our special thanks are due.

#### APPENDIX A.

##### ON THE RELATION OF BACTERIA TO ASIATIC CHOLERA.

In order to understand the exact relation of organisms to the cause of disease, the following circumstances have to be well borne in mind:

(1) A disease may be caused by a virus which is the product of an organism, but the disease is not a communicable one, or, with other words, the disease is not an infectious disease. An example of this kind we find in septic or putrid intoxication.

As is well known through the researches of Gaspard, Panum, Bergmann, Sanderson, and others, certain products of putrefaction, resulting from the activity of the putrefactive bacteria on nitrogenous compounds, outside the animal system or within, when introduced in small quantities into an animal or man, produce a transitory pyrexia, and if the quantity of the material is sufficiently large, in addition, symptoms of acute poisoning, as vomiting, purging, hemorrhage in the various serous and parenchymatous organs, collapse, and death.

In these instances the poison itself can be and has been isolated and separated from the putrefactive organisms which produce it.

The blood and tissues of an animal thus poisoned do not while fresh contain organisms, and possess no infective properties.

Koch describes the nature and action of the cholera virus in a similar manner, viz, it is a product of (not putrefactive but specific) organisms, *i. e.*, the comma bacilli. The poison itself,

as in the case of putrid intoxication, is a chemical, *i. e.*, not organized, ferment produced by the comma bacilli, which, having found entrance into the alimentary canal, multiply rapidly and produce the ferment which absorbed into the system induces the whole chain of symptoms constituting cholera. Just as in the case of putrid intoxication, the directly active virus requires for its production the putrefactive bacteria; so also in the case of cholera, the cholera virus presupposes the existence and multiplication of the comma bacilli. The essential difference between the two cases is this, that in the putrid intoxication the putrid poison, as is evident from the nature of things, can be produced outside the body, and can be isolated from the organisms; whereas in cholera the comma bacilli can only unfold their poisonous activity within the alimentary canal, *i. e.*, in the system itself. As has been shown on former pages, these inferences of Koch as to the relation of the cholera process to the comma bacilli are based on propositions which have not been proved, and therefore can not be accepted, and besides they necessitate the assumption of direct contagion, which is in opposition to all that is known of cholera.

(2) Or a disease may be caused by a poison which is produced under certain conditions, but always outside the animal body, say in a suitable soil, and when finding access into the body and without reproducing itself here sets up a definite group of symptoms. This poison may be the outcome of fermentive processes caused by an organism or not, *i. e.*, by peculiar chemical ferments. Thus, in malarial and other fevers, the virus does not reproduce itself within the body; it is produced outside the body in a peculiar soil. Whether it is produced by the agency of organisms or by purely chemical fermentive processes is a matter of detail to be discussed below. At any rate, this group comprises non-infectious diseases allied to those of the former category.

(3) Or a disease may be an infectious disease and caused by an organism in the true sense of the word.

This class comprises diseases which have this great and essential character in common, that they are directly transmissible. In their process of transmission there is always only an almost infinitesimal quantity of virus required to start the disease; that in every infected individual this virus multiplies to an enormous extent, so that all affected tissues and sometimes the blood teem with virus. And it is owing to this fact of self-multiplication that it appears *à priori* probable that the virus in infectious diseases is a living entity.

In anthrax, glanders, tuberculosis, erysipelas, swine fever, fowl cholera, various kinds of septicæmia, etc., this entity has been definitely identified, isolated, cultivated, and with it the disease reproduced. In all these instances it has been found to be an organism belonging to the tribe of bacteria (micrococcus, bacterium, and bacillus), and in all these instances the same kind of organism has been found in the blood or diseased tissues of the individual infected either with the artificial cultivation or the original material. In other infectious diseases this whole chain of evidence is incomplete, *i. e.*, typhoid fever, small-pox, syphilis, the organism has not been clearly demonstrated. In still other infectious diseases the organism has been identified, but not isolated, and its activity has not been tested, *e. g.*, relapsing fever. In a last group of infectious diseases it has been identified and isolated, but owing to the unsusceptibility of animals to the disease its activity can not be tested. Such is the case in leprosy.

(4) Or a disease might be due to a virus which, although undergoing multiplication within the body of a person affected with the malady, does not leave the body as actual virus, but requires some intermediate stage to become so. An instance of this kind is not known.

A disease of this kind would be an infectious disease, but not exactly in the same sense as one mentioned Sub. 3.

Now, the question arises, in what category of diseases should cholera be placed? The first point, and the one which is obviously of the greatest importance, is this, is cholera an infectious malady in the true sense of the word or is it not?

Is cholera a disease of which it can be said that the virus introduced into a suitable individual increases to an enormous extent, and thus yields a crop of new virus, the smallest quantity of which when finding access to a new individual is capable of starting the malady, like anthrax or small-pox?



As is well known from the immense literature of the subject, there are a good many observers who, on account of their Indian experience, question the correctness of the view that cholera can be communicated from individual to individual, either directly or indirectly, *i. e.*, through human intercourse, but they maintain that cholera, like malarial and other fevers, is independent of human intercourse, but owes its origin to peculiar fermentative products of the soil. According to this view, the doctrine of *contagium vivum* does not apply to cholera.

Now, this view as to the independence of cholera on human intercourse must and does appear to medical men in Europe very strange, considering that the history of almost every visitation of European countries by cholera clearly points to the invasion of the disease by human intercourse. But when one comes to consider the conditions obtaining in India, such a view as above stated to be held by very experienced observers in India loses all its strangeness.

One of the best-established facts in connection with cholera amongst Anglo-Indian troops in India, and on the strength of which invariably successful action is taken, is this: That as soon as in any cantonment cholera appears amongst the soldiers the troops, including those affected, are removed to camp, and cholera ceases.

If cholera were communicable directly or indirectly from one individual to another, why, one may ask, should it cease under these new conditions, since in many instances cases contracted in the cantonment, but coming to head only after removal into the new camp, are still there to sow the virus? The habits of the soldiers remain the same, the evacuations are disposed of in the same way as previously, and nevertheless cholera does not spread. Or, take the conditions obtaining among the native populations. Benares, as is well known, is a center in which continually large numbers of pilgrims congregate.

The sanitary conditions prevailing in this, as in other cities, are so primitive that, seeing and to a great extent smelling the insanitary state, one is lost in amazement how it is possible if this theory be correct that cholera is not constantly there epidemically. The Ganges, on the shores of which the city is located, is considered by the Hindoos as the sacred river, and therefore ablutions in it by the pilgrims and natives of the town are carried on to an enormous extent.

But not only external ablutions, internal ablutions as well, as also washing of garments and linen, are carried on on a large scale.

It is a curious sight to see hundreds of Hindoos bathing in, washing their mouths and teeth with, as well as drinking, the water of this filthiest of waters. One of the main drains of the town discharges its filth into the river at a place close to the nest of temples. The number of people bathing here, washing their mouths and teeth, washing their clothes, drinking, carrying away the water in vessels for domestic use, at this very spot, in intangible proximity to this unsightliest outlet, is simply extraordinary.

The drainage of the city is so defective that in every street the stagnation in the drains is a thing that obtrudes itself in a very unpleasant manner to the eye, and still more to the nose, and this finds almost its climax in the very vicinity of the temples and shrines, where constantly processions of pilgrims pass up and down. The domestic arrangements are of the most primitive nature. Some sort of latrines are found even in the houses of the poorest, but these latrines communicate only with defective, and in many instances stagnant, drains, and, besides, a contamination by human dejecta of the house wells is not only not excluded, but is, one might say, the rule. And this is not only the case in the poorest houses, but, as direct inspection proved, in well-to-do establishments.

Even the public wells, of which there are a great many in the town, and the water of which is ostensibly used for drinking purposes, are such as not to exclude constant contamination. They are surrounded by a raised platform of masonry, and on this platform there is washing of clothes carried on. Now, in every well that was examined the masonry of the well itself was defective, and in several instances the fluid filth was distinctly seen oozing into the well through the defective masonry.

Now, if under these conditions a case of cholera occurs in any locality of the town, how, one might reasonably ask, is it possible that this can ever remain isolated? How is it that it is

not followed by an epidemic outbreak of the disease? That the people of Benares have not become unsusceptible to the disease is proved by the fact that epidemics do occur occasionally. In the latter half of October, that is, some time after the rains, Benares had only a few isolated cases, although the sanitary conditions are such that an epidemic then and at all times would have been the very thing to be expected.

Or take the conditions obtaining in Bombay. In two quarters of Bombay, Dobie Talao and Cavel, there occurred a good many cases of cholera during the month of September.

In both there is an attempt at drainage, but owing to the habits of the people of using the street gutters instead, any attempt of collecting and guarding human excreta must be futile. Not only is this the case, but the excreta in some streets (owing to the heavy rains) find their way from the water-closets at the back of the houses into the streets, and here the liquid sewage can be seen and smelt spreading in the gutters and all around them. In addition to this, there are wells situated in the street, or in some instances, *e. g.*, in Dobie Talao, at the back of the houses. In both instances the passage of the liquid sewage into the wells through the defective masonry can be detected without any difficulty.

Although the people are not supposed to drink from this water, using it ostensibly only for washing of clothes and domestic utensils, it is nevertheless a well-known fact that sometimes they do use it, since the water supply (from the Vihar) is an intermittent one, and in case of the deficiency of this drinking water (which occurs during the day-time), the people do not hesitate to use the well-water for drinking purposes. On first questioning them they do not, of course, admit it, but on cross-examination it has been invariably brought out that they did and do use it so.

In addition to all this, one must bear in mind that their cooking utensils must be constantly contaminated with filth and filthy water, and to all this add the habits of the natives of eating with their bare and by no means clean fingers, and one can easily understand that they embody a considerable amount of filth in the shortest time.

In an alley in Cavel in which lived about 50 people, each family in a small room leading out into a common court, there occurred in one of the rooms two cases of cholera, two brothers, mendicant priests. The sanitary conditions here were the same, or worse, if anything, the people all being very poor, and the habits of these brothers in the way of disposing of their filth differed in no way from the general rule, and nevertheless no more cases of cholera occurred here. The sanitary conditions existing in other parts of the town, and particularly in villages, are simply described by the word *nil*, and nevertheless a case of cholera occurs occasionally, but does not spread. The disposal of the excrements, the washing of clothes, linen, and utensils in the water (tanks) used for general and drinking purposes, all their habits, their eating with unclean hands or after washing them with the filthy water, are the same.

In Calcutta the conditions among the natives, in groups of huts (bustees) interspersed amongst European houses, and often situated around a tank, are the same everywhere; tanks, supposed to be only ornamental or for drinking purposes, are nevertheless, as may be seen almost everywhere, used by the natives for their external and internal ablutions, for washing their clothes, and even for more unsightly though natural purposes, and the natives often drink this water.

How is it, then, one might reasonably ask, that if once a case of cholera occurs in one of the houses around such a tank, it does not spread? That at certain seasons of the year (during the months of January, February, and March) it assumes considerable and sometimes alarming proportions is no answer to this question, since during the hot season, when it ought to spread, if the contagionist theory pure and simple were true, it ought to be more prevalent, whereas just the contrary is the case.

Now, do not all these facts support in a conspicuous degree the view held by many experienced observers, that cholera is not directly communicable from the sick to the healthy—that it is independent in the first place on locality and season?

What, in the face of such facts, which could be multiplied many times, and had been done so in a most clear and thorough manner by Bryden, v. Pettenkofer in all his writings, from



experiences in India and Europe (*e. g.*, the immunity from cholera experienced by Versailles, Lyons, and other cities), becomes of the view of the contagionist, who, like Virchow, Koch, and others, must of necessity maintain the possibility of direct contagion, if the comma bacillus is to be of any account in the matter? The perfectly gratuitous statements of Koch (*l. c.*) as to the ready and direct transmission of the disease by linen soiled by evacuations of cholera patients, the still more gratuitous assertions as to the spread of cholera on shipboard from patient to patient, lose all significance when compared with the abundant and overwhelming evidence as to the non-communicability of the disease directly from the sick to the healthy, and as to its dependence on locality and season.

Even granting for the sake of argument that Koch's statements with regard to the distribution of the comma bacilli are correct (statements which have been shown previously to be in flagrant opposition to the facts observed by us), his inferences that the comma bacillus is the cause of cholera can not be true, since cholera is in an eminent degree a malady which is not directly communicable from the sick to the healthy, but which it ought to be under all conditions if it were dependent on the comma bacilli, seeing that these are voided by the sick in enormous numbers, and that they, in India at any rate, find constantly and copiously access to the system of persons. If additional proof were required to bear this out, the experience in the hospital of the medical college in Calcutta where Koch worked, and as is well known in other hospitals in India as well as in Europe, might have furnished Koch with it. Here cholera patients are put more or less indiscriminately amongst other patients, and still neither attendants nor other patients ever contract the disease.

Every one accustomed to work with bacteria knows well how insignificant and useless ordinary precautions of cleanliness are of keeping bacteria out from where one does not want them, and the comma bacilli would make no difference from this.

True, Koch says that the comma bacilli being killed by drying, particles of the evacuations, although at first full of living comma bacilli, would by drying on linen, on the floor, etc., become non-infectious. Now, as is well known, micrococci and bacterium termo are also killed by drying, and as these have no spores, *i. e.*, permanent seeds, contamination of culture media by them simply through the air should be impossible, and nevertheless, as is known to every worker in this field, the contrary is the case. This simply proves that the micrococci and bacterium contained in minute particles of putrid substances wafted about by air currents are not really dry, since, if they were so, they would be dead, and could not produce contamination.

That in a ward where several cholera patients are constantly soiling the floor and beds with their evacuations, and where the attendants are constantly handling these, it is absolutely inconceivable that no contamination of their persons should occur with the organisms present in the evacuations, and amongst others also with the comma bacilli; to say that probably the attendants are probably in robust health, and therefore insusceptible, does not meet the case, because some of the attendants are not so, and besides, what of the other patients in the wards? A visit at meal-times, seeing sick and weakly patients eating with their fingers, would soon convince everybody of the absurdity of such a view.

Another point which Koch adduces to explain the non-communicability of cholera directly from the sick to the healthy is this: Koch says that the comma bacilli can not live in acid medium, and therefore, when taken into the stomach of a healthy person, they can not pass unscathed into the small intestine, their breeding ground. But this assertion of Koch's as to the fatal influence of acid on the comma bacilli is not borne out by observation; on the contrary, the comma bacilli are not killed by weak acid, as has been shown on a former page.

The writings of v. Pettenkofer have fully and satisfactorily explained those few cases of transmission of cholera by linen, not because of their being soiled with cholera evacuations, but because they are derived from an infected locality. In those few instances where, on ships and in a hospital, apparently, a spread of the disease has been observed, this apparent spread has been caused, not because a cholera case was there, but because the ship or hospital had become itself a cholera locality, and it is not necessary to enter here further into this. If anything can be made of these instances, it is certainly not in favor of the contagionists.

There is, then, no reason to suppose that the discovery of the comma bacillus, nor the small straight bacilli above described, supplies the contagionists with new facts by which to support their theory, because, in the first instance, all the known facts as to the spread and distribution of cholera are against such a theory, and, in the second place, because the statements as to the relation of the comma bacillus to the disease are not sufficiently established; but, it might be argued, if the comma bacillus, or the small straight bacillus, are not the cause of cholera, then some other organism must be it, since it is said, with great accentuation, that cholera can be spread by human intercourse. It is further assumed that the cholera poison, or something that can develop into it, having found entrance into an individual, multiplies there, is discharged by the evacuations, finds access to a peculiar favorable locality, and then, supposing other conditions favorable, develops into the real poison, which, having had entrance in some way or another into a healthy person, creates the disease. That the virus is not present as such in the cholera evacuations is clear from the fact that the cholera is not directly communicable; that the cholera evacuations, when brought into a suitable soil, ever develop the virus there is no direct evidence to show; the presumption is great, but as regards direct proof there is none.

The importation of cholera into Europe and the Mediterranean countries, as is well known, can not be traced in all cases to the importation of a person affected with the disease, and in some well established instances (Hirsch, Pettenkofer, Sander, and others) has been traced to the importation of a something—articles of linen or clothing—derived from an infected locality, but which articles had not been soiled directly by cholera evacuations. (See Hirsch, *Berliner-Klin. Woch.*, N. 31, 1884.)

While, then, on the one hand there is direct evidence to show that the cholera evacuations do not and can not contain the active virus, there is also this evidence, that organisms like the comma bacilli and the straight small bacilli, constantly occurring in the mucus flakes, can have nothing definite to do with the disease. But no micrococcus, bacterium, or bacillus, or any other kind of bacterium, fulfills the elementary conditions just expressed.

One might say from the knowledge that bacilli have the power to produce spores that it might be a bacillus. The bacillus itself, as it passes out of the body of a patient, might be inactive, but its spores formed outside the body, in peculiar soil and at certain seasons, might be the active principle. Those who would accept such a view would of course say that the virus is a bacillus which can unfold its poisonous activity only when introduced into the new individual as spores; the fresh evacuations containing only the bacilli are inactive. Allowing, for the sake of argument, this, a simple consideration will show its untenability. These hypothetical spores introduced into the body of a person would germinate into bacilli, and these would then multiply by fission after the manner of bacilli, and hereby produce the chemical ferment necessary to start the disease. Spores of anthrax bacilli introduced into a suitable animal germinate into the bacilli; these multiply to a great extent, and cause the disease known as malignant anthrax. And this simile might be further carried by saying that, just as is the case with the anthrax bacilli, they do not form spores unless certain conditions, as temperature, moisture, and free access of air, so also the hypothetical bacilli vacuated by a cholera patient, would produce spores only when placed under the necessary conditions. But this simile suffers from a cardinal defect; it is this: in anthrax, the bacilli are as virulent as the spores, and there is no case known of bacilli, septic or specific, in which the bacilli themselves have not precisely the same functions as their spores.

It might be said that, as is the case in some conditions in anthrax, the bacilli may be innocuous, whereas their spores may be poisonous, *e. g.*, bacilli taken from the blood of an animal dead from anthrax, when grown at high temperatures (42 to 43 C.) for sufficiently long time (two to three weeks), may lose their activity entirely on sheep, whereas if the bacilli are used when growing at ordinary temperature or when allowed to form spores prove active on sheep. And it might be said that a similar thing may be the case in cholera, *i. e.*, the hypothetical bacilli of the evacuation might be inactive, but when growing under certain conditions (of soil and season) may prove active either as bacilli or after having formed spores. But it must be evident that the cases are widely different from one another. The comparison could



be applied with a certain semblance of feasibility if the anthrax bacilli produced in one animal and used fresh proved inactive on the same species, but acquired potency when grown under conditions different from those obtaining in the animal body. As far as our knowledge goes, just the contrary is the case with all pathogenic bacteria, they being potent when fresh, *i. e.*, directly taken from the infected animal.

The strongest reason for not admitting this kind of bacillar relation to the disease is this, that no bacilli exist in the blood or any other tissues of patients suffering from cholera.

There is absolutely nothing that in the remotest degree could bear out such a bacillar origin.

The blood and other tissues, intestines, mesenteric glands, liver, spleen, kidneys, lungs, spinal cord of acute typical cases have been carefully examined after the approved modern methods, and nothing could be found of bacilli, except occasionally, but comparatively rarely, a few bacilli, clearly of putrefactive origin, could be seen in the portal vessels of the liver, in the dead portions of the mucosa of the stomach, and in the cavity of the Lieberkuhn's follicles, as well as in the spaces between the detached epithelial lining and the membrana propria of these glands, but this only rarely and in very few places, and when it occurred it was clearly due to post-mortem changes. Cholera disease is so rapid in its development and course, its symptoms are so complex, and so many different nerve centers, as the centers of circulation and respiration, secretion, the alimentary canal, and muscular system, are affected that there can be no doubt that the actual virus must have found entrance into the blood and circulation, and thence is distributed to and acts on the various centers. Koch, not finding any comma bacilli anywhere except the intestines, overcomes the difficulty by saying that the actual virus is a chemical ferment, produced by the comma bacilli in the intestines, and its absorption into the system sets up the symptoms of the disease. But since the assertions on which the theory is based are not sufficiently supported, *i. e.*, the assertion as to the presence of the comma bacilli in the living tissue of the intestine, this theory can not be accepted. For the same reason the small straight bacilli can have nothing to do with the disease, and, as there are no other organisms present, it follows that *the body of a patient suffering from cholera contains no organisms of any kind that can be associated with the disease.*

From all this it appears that there is no evidence obtainable that the disease is associated with a distinct specific form of bacteria, a fact which was expected from reasons stated above.

The *à priori* probabilities of there being a micro-organism connected with the disease belonging to a higher order than bacteria (*e. g.*, hyphomycetes, etc.), are not much greater than for the bacteria, for although they very often show very complicated changes in their process of growth and development—witness the complexity of the growth and development of a penicillium, aspergillus, mucor, saprolegnia, etc.—it is an established fact that in all these instances where the mycelium succeeds in growing and thriving also the spores succeed in germinating and giving origin to the mycelium. It might be said that it requires the spores to set up the disease, for they can make a start where the mycelium might be incapable to do so, and this is to a certain extent borne out by the observations of Grohe, Lichtheim, and others, who have shown that after the introduction of the spores of certain species of aspergillus into the rabbit a general mycosis can be produced, and concluding from this it might be argued that, supposing cholera to be due to a hyphomycetes, and supposing also that it were necessary that the mycelium should be first brought into a proper soil and at proper time—and thus satisfying the theory of the localists—in order to be capable of forming spores, which, when finding access into the human body, set up the disease cholera.

This may be possible but it is not probable, for the simple reason that in cholera there is no part of the body where anything of a spore or mycelium can be detected.

(Assertions have been made that there have been seen in rice-water stools that had been kept for four days organisms in the shape of a kind of mucor, which form cysts, which again give origin to spores, which again give origin to mycelium, which again produces cysts, which ultimately yield a crop of comma bacilli; but all this, on account of its inherent improbabilities,

the coarseness and superficiality of the method investigation, is so absurd and is so much at variance with what is known of these microphytes that it neither requires nor deserves serious consideration.)

Thus the conclusion is forced on us that in cholera no micro-organism that can be in any way connected with the disease is present in the body of a person affected with cholera.

How then is it possible to explain the invasion by, and spread in a locality of, the disease? No doubt the assumption of a specific living organism, which, in one form or the other, having gained entrance into a person, there multiplies and produces the disease, and then is passed out in enormous numbers into soil suitable for the peculiar change, in the course of which it assumes its potency, is a feasible one, and at the same time simple, and it is one towards which, in some of his later writings at any rate, v. Pettenkofer inclines, who as yet has given the most satisfactory view of the mode of propagation and causation of the disease as contrasted with the view of the contagionists, who assume an organism capable of starting the disease as it passes out of an infected body.

As stated just now, the assumption of a micro-organism passing out of a choleraic patient being indirectly connected with the disease, *i. e.*, by and by acquires a potency, is very simple, but it is not absolutely necessary, and, as has been shown, is contrary to the facts observed.

Supposing somebody maintained that the choleraic evacuations contained the virus in a potential state; as has been shown above, this can not be an organism, since the organisms present in the evacuations do not fulfill the elementary conditions required of the choleraic virus, and therefore he would have to assume that it is a chemical ferment. But against such a view there is this great difficulty, that this potential virus must be capable of self-multiplication, for introducing an infinitesimal quantity of it from a cholera locality into a new place it is capable of producing an epidemic outbreak of cholera. A self-multiplying thing can not be simply a chemical ferment; according to all our notions this must be a living organism.

In the face of the fact that no micro-organism hitherto proved as connected with infectious diseases would fulfill all the conditions required of the cholera virus, and detailed on a previous page, and in view of the fact that no micro-organism can be found in the body of a person affected with cholera, as being connected with the process of the disease, it is impossible to maintain that the evacuations of a person affected with cholera contain actually or potentially the cholera poison in the shape of an organism, and from this it follows that the direct cause of cholera is not an organized ferment which has found entrance into the body of the patient, which there multiplies and passes out again in enormously increased numbers, but it must be some kind of ferment produced altogether outside and independently of the body of a cholera patient.

There can be no question that a cholera case introduced into a suitable locality can and does transform this locality into a center of the plague, and there can be likewise no doubt that cholera can be and is occasionally introduced, not by a patient at all, but by some articles coming from an infected locality. Pettenkofer,\* in his various writings on this disease, has very clearly drawn attention to all these facts, and it is not necessary to enter further into them here. Some very remarkable instances of very rapid infection (half an hour to a few hours) through linen soiled with choleraic evacuations, and coming from a cholera-infected locality, are given by Professor Drasche, of Vienna. (*Der Pilzfund in der Cholera*, Vienna, 1884, pp. 14, 15.)

The cholera virus producing an epidemic is then created in this new suitable locality by something transferred to it from an infected center. This something must obviously be self-multiplying, and, as no chemical ferment fulfills this elementary condition, it is necessary to assume that this something is a living entity, an organism. And as stated above, the direct

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\* That the choleraic evacuations *per se* do not contain the virus is a conclusion in harmony with all the facts known of the disease, for otherwise the disease would be directly contagious, which, as has been shown, it eminently is not. Pettenkofer, in his little pamphlet "*Die Entdeckung des Cholerapilzes*, Munchen, 1884," gives on page 8 and *passim* a very remarkable instance of an epidemic, that of the prison Laufen, in which the harmlessness of choleraic evacuations, recent and old, is well illustrated.



virus being a chemical or non-organized ferment, we arrive at the conclusion that a living organism transferred from a cholera locality into a new and suitable soil therein multiplies and gives rise to the production of a chemical ferment, which, when finding access to the body of a person, sets up the disease cholera.

The alkaloids known as ptomaines, produced by micro-organisms outside the animal body and acting as deadly poison to the animal economy, may be quoted as an illustration. Exception might be taken to this theory, on account of the difficulty of explaining the incubation after infection with chemical poison. But the difficulty is far less than at first appears. The chemical poison present in the seeds of *abrus precatorius* or *jequirity*—the *adrin* of Messrs. Waddell and Warden—requires generally 24 hours to develop its poisonous property, consisting in inflammation and œdema at the seat of inoculation, followed by death of the animals after two or three days.

It might be asked now how it is possible to explain on this theory the well-known fact that linens soiled with choleraic evacuations have been capable of infecting with cholera persons who have handled these articles, unless by the theory that the evacuations after some time have developed the virus?

In the first place it is equally well known that such an infection is, on the whole, of rare occurrence, and one will ask in return if the cholera evacuations are capable of developing the virus, how is it that this kind of infection is of rare occurrence?

Clearly because the evacuations alone are not capable to develop the virus, but in those cases in which they acquired this power something else had been added, some organism capable to develop the virus while growing in the evacuations. This leads us, then, to this theory. The cholera evacuations alone do not contain the virus either potentially or actually, but if something else, the extraneous specific organism, finds access to them, this is capable to produce the virus in the evacuation. But this organism does not necessarily require cholera evacuation for its multiplication and for the creation of the virus, since it is capable of doing this also in other suitable soil.

This theory, then, seems to be capable of explaining all the facts concerning cholera. To repeat it, the cholera evacuations, per se, do not contain, actually or potentially, the organism which by its multiplication creates the cholera virus, a chemical ferment; this organism is extraneous to the body of an affected person; when transferred to a suitable locality or when finding access to the cholera evacuations or other filth it is capable of multiplication, and of creating the chemical ferment, the actual virus.

Once having been created, the choleraic virus is introduced into the human body in various ways. A view favored by many is the one that water is constantly the vehicle, others assume in addition the food, still others also the inspired air. There exist on record a good many cases in which water as the vehicle of the virus is put forward as having been proved, but the majority of these, on critical examination, do not stand. There can, on the other hand, be a good many instances quoted where water contaminated with choleraic evacuations can be proved to have been incapable of producing the disease. There is in India not a tank, not a pool, not a well in town or village to which, on the one hand, choleraic evacuations have not access, and from which, on the other, the natives do not use the water for drinking purposes, and nevertheless, except in years of epidemics, isolated cases only are heard of around these tanks and wells. One might reasonably ask, if the cholera evacuations contained the virus, why does not one case of cholera at once produce a wholesale outbreak? Benares was mentioned on a former page as giving a good illustration; so does many a quarter in the native part of Bombay, so do many localities in Calcutta, and so do almost every city and village where a case of cholera does occur.

The cases, such as the noted Broad-street pump outbreak, where the water had been notoriously contaminated by sewage and choleraic evacuations, do not prove that these latter contained the virus, since, if cholera evacuations had access to the well, then also other matters of the soil may, and probably have, had access to it.

That water can be a vehicle, provided the virus formed in the soil has had access to the water, is, however, altogether a different matter. Such cases, well established, are on record, and amongst them the cases quoted in the sanitary reports for India, in those of the Local Government Board of London (the Broad-street pump epidemic), with reference to London water supply, are good instances. In order to satisfy the condition that dilution of the virus by water would neutralize the action of the virus if it were simply a chemical substance, it is necessary to assume that the (chemical) virus is fixed on solid particles, possibly on the organisms that produce it.

And similarly, there is no reason to exclude food as a vehicle, provided it becomes contaminated with the material containing the virus either directly or through water. And likewise the possibility of the virus getting access to the body by means of the inspired air is perfectly admissible (see Dryden Reports on Cholera in the Bengal Presidency from 1817 to 1872), considering that, if the virus is created in the soil, it can escape the soil in various ways, and be inhaled by a human being just like the malarial poison, and, further, considering that the nature of the disease cholera is such as to necessitate the assumption that the virus must have entered the blood in order to start all those complex symptoms, due to the disturbance of so widely different centers and organs. In addition to this there are several well-established instances known in which the handling of linen previously soiled with choleraic evacuations has been capable of producing cholera within as short a time as half an hour (see "Drasche: Der Pilzfund bei der Cholera," Vienna, 1884). In these instances clearly the virus must have been a chemical ferment that had found access to the organs of circulation within such a short time, which it could have done only by the respiratory organs.

#### APPENDIX B.

##### ON THE RELATION OF WATER CONTAMINATED WITH COMMA BACILLI TO CHOLERA.

The assumption by Koch that the comma bacilli are connected with the cause of cholera has received a remarkable confirmation by Koch himself. As will be remembered, Koch, while in Calcutta, by one of his later reports to his Government, and particularly by an article that appeared in the "Englishman" of Calcutta, 18th February, 1884, the substance of which article has been telegraphed to all European papers, has greatly startled all those that did not at once readily believe in the comma bacilli as the cause of cholera. Koch therein states that cholera having broken out in one of the bustees surrounding a tank in a suburb of Calcutta, he visited this bustee and found numerous comma bacilli in its tank. On his second visit, a week later, the epidemic being on the decline, he found much fewer comma bacilli in that water, and this seemed to him and the "Englishman" to furnish positive and remarkable proof that these comma bacilli were the cause of the cholera outbreak. It is known to all who have been in India, and has been mentioned on a former page, that the natives use the water of every tank, ditch, and pool, however dirty and filthy, for all kinds of purposes—bathing, washing of mouth, washing of domestic utensils, washing of clothes and linen, and even for drinking purposes.

This particular tank visited by Koch, like most other tanks, is surrounded by native huts, and is used as a common reservoir, into which the evacuations of man and beast and every kind of domestic filth find access.

That the water of such a tank, around which cholera cases occur, and into which the evacuations of cholera patients find access, and in which the clothes soiled by cholera dejecta are washed, should contain the same comma bacilli that are present in the choleraic evacuations is what one would naturally expect, and likewise that the number of these comma bacilli should be fewer the fewer the cholera cases, *i. e.*, the smaller the number of comma bacilli thrown into the water. But to conclude, as Koch does, that because there are comma bacilli in the water cholera cases occur amongst the people using the water, and as soon as the number of comma bacilli decreases in the water the number of cholera cases become less, is manifestly



illogical. That Koch should have used an argument of this nature to build up his theory is only intelligible if we remember how little convinced some of the medical public appeared to be of Koch's theory by his reports, and that it requires, as it were, a much stronger argument to confound his critics. This discovery of the comma bacillus in the water in that tank was considered such an argument, as is clear from the manner in which at the time the daily and some of the medical papers wrote about it.

That the cholera virus, whatever this is, can find entrance into a person by being conveyed there by water is in perfect harmony with the facts of the case, and that pure drinking water not contaminated with any extraneous material is of the greatest importance finds a very good illustration in the reports of the privy council office, in the Broad street pump cases in London, and in the various Indian sanitary reports.

Another curious illustration how even a very experienced observer like Koch sometimes becomes unable to interpret correctly plain facts is furnished in the same reports he sent to the German Government. Koch states that in Fort William, in Calcutta, cholera abated as soon as a good water supply to the fort was introduced, and takes this of course as proof that, previous to the introduction of the good water supply, many cholera cases were due to contaminated water. Now, had he taken the trouble, as he might easily have done by looking at the records, he would have found that such a conclusion is quite out of harmony with the actual facts, for he would have convinced himself by studying the records that cholera cases diminished in a very marked degree some years before the introduction of the better water supply, and that this diminution, but no greater one, was kept up afterwards.

The Indian Medical Gazette, of November, 1884, republished, on page 332, the official statistics as to the course of cholera in Fort William from 1856 to 1876. In 1863 there occurred a sudden decrease of cholera, and this decrease was kept up till 1876. But the new and pure municipal water supply was not introduced in 1862 or 1864, but in 1872, *i. e.*, nine years later than the conspicuous decrease of cholera.

We have had the opportunity in connection with Dr. D. D. Cunningham to make an examination of the water of some of the tanks in Calcutta with reference to this very question of the comma bacilli.

The same tank that plays such a conspicuous part in Koch's report above mentioned was visited on the 26th of November. It is situated in Sahil Bagan, a suburb of Calcutta, and is marked Tank I; it is surrounded by native huts in which about 200 families are living. There had occurred one case of cholera in this bustee about the first week of the month of November. The water of this tank was very dirty, particularly all along the shore, and the people all around the tank, as is customary, made use of the water for all and every kind of domestic and other purposes, including drinking.

A sample of this water was taken from near the shore, where it appeared particularly impure, about 20 yards from the house in which the cholera case had occurred, and the microscopic examination revealed undoubted comma bacilli identical in every respect with those found in choleraic dejecta. Notwithstanding their presence in this water, and notwithstanding the extensive use the 200 families were constantly making of it, there has been no outbreak of cholera. Now we have in this instance an experiment performed by nature on a scale large enough to serve as an absolute and exact one. This water had been contaminated with choleraic evacuations, and of course with comma bacilli, and it was used extensively by so many human beings for several weeks; if, to speak with Koch, the comma bacilli were the cause and essence of cholera, how is it that not one person amongst so many has, until the middle of December, contracted the disease? Clearly because the water did not contain the cholera virus, and because this latter has nothing to do with the comma bacilli.

It might be said that perhaps the comma bacilli present by the end of November were not the same as the cholera bacilli, but it must be remembered that there having occurred here a case of cholera, owing to the conditions obtaining here and owing to the habits of the people, large quantities of cholera bacilli must of necessity have been thrown and carried into this tank. Along the shore the water contained abundance of decaying animal and vegetable nitrog-

enous material to form a very good and suitable nourishing medium for the bacilli, and they must have had ample opportunity to multiply, and consequently there must have become large numbers of them available sufficient for hundreds of human beings. And nevertheless no case of cholera occurred.

And the same argument can be applied to most tanks and to most bustees in which once a case of cholera has occurred. The comma bacilli of the choleraic evacuations find ready access to the water of some of the tanks, and there is absolutely no reason to suppose that they would not multiply, at any rate near the shores, where there is always present a good deal of decaying animal and vegetable matter, and contaminate the whole of the water of the tank, and consequently there ought to be an epidemic in the bustee surrounding such a tank. But this is manifestly not the case.

Close to this bustee is another bustee surrounding a tank. Also in this bustee there are about 200 families. The water of this tank is as dirty as that of Tank I, and is used as extensively as the former. A sample of water taken from near the shore and examined under the microscope revealed, besides numerous bacillus subtilis, examples of undoubted comma bacilli in every respect identical with those found in Tank I. Amongst the 200 families living around this tank, and constantly using this water, there has not been a single case of cholera during the whole of 1884.

An equally striking illustration of the innocuousness of the comma bacilli is furnished by a tank situated near Teleepara lane, in Calcutta. Between the 14th and 16th of November there occurred 9 cases of cholera in three houses of Teleepara lane. In the accompanying plan the three houses are seen situated around a bend of the street, and they are Nos. 3, 4, and 34. No. 34 had 3 cases, No. 3 had 3 cases, and No. 4 had 3 cases. The people of No. 34 are rich Hindoos, and also those of No. 3 and No. 4 are well-to-do. Two of these three houses have their own hydrant, and from it they have a good supply of very clear water, such as is supplied to all good houses in the town. There is no condition common to all three houses, except that just in front of each of them, there appears to be a communication with the street sewer. A narrow passage leads from Teleepara lane to a bustee surrounding a large tank.

As is usual, the people (low caste) living in this bustee make extensive use of the water of this tank, but the people of those three houses, being well-to-do and having their own drinking water, never went near this tank. In one of the huts of this bustee lives a milkman, who supplied, amongst others, house No. 34 of Teleepara, but not No. 3 or No. 4. The water of Tank III, as usual, is very dirty, especially near the shore, and a sample of it examined under the microscope revealed the comma bacilli. Amongst the people of this bustee there has not occurred a case of cholera during the whole year.

It is quite clear from all this that the statement of Koch and his adherents as to the importance of the comma bacilli in the water in producing cholera is in direct opposition to the above facts.

#### REPORT ON THE CHOLERA BACILLUS.

By W. WATSON CHEYNE.\*

In view of the great importance of the etiology of cholera, I have for some months past been engaged in observations on that subject, and during the epidemic of Asiatic cholera, in Paris went I over there and made some investigations on the bacteria present in the dejecta. The present paper gives the results of these investigations; and to the report of my work and the conclusions to which I have arrived I have added an appendix, in which reference will be made to the observations of others, more especially to those of the English commission.

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*Conclusions.—Diagnostic value.*—If now we consider carefully the meaning of the foregoing facts, it will be evident that the discovery of the cholera bacillus is a most valuable addition to our knowledge, quite apart from the conclusions which may be come to as regards its casual connection with Asiatic cholera, for, in the first place, it seems to be constantly present in Asiatic cholera. I do not mean to assert that the cases I have examined are

\* Reports to the scientific grants committee of the British Medical Association, British Med. Gazette, 1885.



sufficient to prove this, but they are, nevertheless, very striking, for I had not selected the cases in any way. I did not say, "This seems a typical case of the disease, I will examine it," or "this does not seem a good case, I will not have material from it." I was glad to take all the material offered me, without reference to whether it came from a typical case or not, the only stipulation being that it should come from a recent case. Therefore, the foregoing cases, though few in number, afford very strong confirmatory evidence of the statement that these organisms are always present in Asiatic cholera. This is a fact which is, I think, hardly disputed. In the second place, this organism has never yet been found anywhere else than in Asiatic cholera. I have mentioned a large amount of evidence in support of this statement, and for my part I am now thoroughly convinced that it is correct. As I have pointed out, various organisms with somewhat similar morphological characters have lately been described, but accurate examination has shown that these are different from the cholera bacillus, and can be readily distinguished from it. Hence the converse of these propositions necessarily follows, namely, that if the cholera bacillus be found in dejecta, these dejecta must have come from a patient suffering from Asiatic cholera; in other words, the presence of this bacillus may be used as a means of diagnosing Asiatic cholera. The only fact which could be brought forward against this view is that Dr. Klein states that by acclimatization he is able after a time to cultivate the comma-shaped bacillus found in saliva in the same material as is employed for the cultivation of the cholera bacillus, and that these cultivations are identical with those of the cholera bacillus in many respects. I shall refer in detail in the appendix to Dr. Klein's statements with regard to the salivary bacillus. Let us, however, suppose for a moment that they are correct, and let us further suppose that the cultivations obtained by acclimatization are identical with those of the cholera bacillus, not merely in many respects, but in all respects; how would that affect the diagnostic value of the cholera bacillus? It would not interfere with its value as a diagnostic sign at all, for Dr. Klein states that, *in the first instance*, the salivary comma bacillus will *not* grow in the alkaline nutrient jelly used for the cultivation of the cholera bacillus; it must be acclimatized. If therefore the comma-shaped bacillus constantly present in Asiatic cholera be the same organism as the salivary bacillus, it must have been "acclimatized" as the result of the choleraic process, for it will grow in the first instance in the alkaline nutrient jelly. But the absence of the cholera bacillus in diarrhea from other causes and under other circumstances proves that this "acclimatization" does not occur in other diseases than in Asiatic cholera. Hence if, *in the first instance*, cultivations of cholera bacilli be obtained in the alkaline nutrient jelly from dejecta, these dejecta must have come from a case of Asiatic cholera, this condition being necessary, as I have just pointed out, whether one holds that the cholera bacillus is casually related to cholera or that it is merely the salivary comma bacillus "acclimatized" by the choleraic process. I feel certain, therefore, that I am not in any way misleading the members of the association when I state that the presence of the cholera bacillus in dejecta may be held to be a diagnostic sign of Asiatic cholera.

The importance of this discovery can not, I think, be overrated, for it is probably only at the commencement of an epidemic that much can be done to arrest the spread of the disease, and if we can with certainty diagnose the first case as true Asiatic cholera an immense point is gained. In any suspicious case the patient can be isolated, his dejecta thoroughly disinfected, and all the necessary precautionary measures adopted, while in the meantime it is being ascertained whether or not it is a case of true Asiatic cholera. Thirty-six to forty-eight hours would suffice for this purpose, because in thirty-six hours the colonies on the glass plates are visible under a low power of the microscope and their characteristics can be studied. I venture to think that if Koch's work on cholera lead to nothing more than this it is an achievement for which he deserves the very highest praise. The great importance of this matter has been insisted on by Dr. Koch, and has been realized by the German Government. During the past few months over one hundred medical men from various parts of Germany and from other countries have received instructions from Dr. Koch in the methods of cultivating and distinguishing the cholera bacillus, and there are now in almost every town of

Germany men able at once to ascertain with regard to any suspicious case whether or not it is a case of Asiatic cholera. Surely some steps ought to be taken in this country to enable our medical officers of health to acquire like information.

*Causal connection.*—But if we look more closely at the facts it will be evident that there is fair ground for thinking that the cholera bacillus is in some way or other casually connected with the disease. Let us take the two main points which have been discussed in detail in the foregoing paper. In the first place, we have seen that the cholera bacilli are always present in Asiatic cholera in the early period of the disease. Wherever cases of Asiatic cholera have been thoroughly examined, whether in India, in Egypt, in France, in Italy, or in Spain, these bacilli have been found. Wherever the virus of this disease goes the bacillus goes; where the virus disappears the bacillus disappears. The virus has never been found to produce Asiatic cholera without the cholera bacillus appearing at the same time; the two evidently go hand in hand. In the second place, this bacillus has never yet been found in other diseases, or in places where connection with Asiatic cholera is out of the question. And yet, if it be only accidentally present in cholera, it follows, from the fact that it is constantly present in that disease, that it ought to be very widely distributed throughout the world; and ought, therefore, to be readily found quite apart from Asiatic cholera. This, however, is not the case, as I have shown at length in this report. And it must be remembered that it is not one investigator alone who has failed to find these organisms apart from Asiatic cholera; but it is, I might say hundreds, at any rate not much under two hundred, and probably more, who have been searching for it diligently for months without success. When one considers the immense amount and variety of material which must, therefore, have been carefully examined with negative results, the statement that this bacillus is limited to Asiatic cholera must, I think, be taken as sufficiently proved. The only investigator of note whose results seem, at first sight, to lead to an opposite conclusion is Dr. Klein; but, in the appendix, I shall point out facts in relation to his research which diminish very materially the importance to be attached to it.

Now, let us ask what can be the meaning of these two facts; and in doing so we may leave out of consideration for the present the minor points, such as the distribution of the bacilli in the intestinal canal, their relation to the wall of the intestine, etc. Though these may act as additional arguments for or against the view of the casual connection of these bacilli with Asiatic cholera, yet, in the main, have reference to the mode of action of the organism, supposing it be the cause of the disease. Dr. Koch has given in his report the only three hypotheses which may be formed from these facts.

In the first place one might say that the choleraic process favors the growth of these bacilli, by providing a medium in which they can grow more rapidly than other forms of bacteria. But this hypothesis would imply that these organisms are normally very widely distributed throughout the world, which as we have seen is not the case. It is absurd, indeed it is against the facts, to suppose that cholera bacilli are constantly present in every individual and yet are in such small numbers that they can not be detected, for we know that cholera dejecta are not the only soil on which these organisms grow luxuriantly; they grow readily in all sorts of putrescible materials, and if they are constantly present in every individual they must of necessity often meet with soil, either inside or outside the body, in which they can grow well. It is difficult also, to see how they can prolong their existence if they can only grow with difficulty, and in small numbers except when the patient is suffering from Asiatic cholera. Nor is it possible to imagine what their function in the economy of nature could be under these circumstances, for every one of these bacteria has its proper function. Besides, considering the enormous amount of material that has now been examined for them, they would certainly have been found by this time. This hypothesis may, therefore, be dismissed and the other two considered.

In the first place it might be said that as the result of the choleraic process, some common and well-known form of organism changes its character, and becomes converted into the cholera bacillus; or in the second place, it must be concluded that the cholera bacillus is in some way or other casually connected with the disease.



The first conception is quite inadmissible in the present state of our knowledge. We are here brought face to face with the question of the conversion of one form of micro-organism into another. This, though possible on the evolution theory, is contrary to all carefully observed facts with regard to bacteria, and, for this reason, it must be proved beyond a doubt before it can be accepted in any case. The evolution theory is all very well, but it is still only a theory, however probable, and it must not be put in opposition to facts. But, even on the evolution theory, it is hardly possible to admit this view, for change on the evolution theory—such change as involves complete loss of original characters and acquisition of new ones—requires a long time, a great number of generations.

Now, what is a generation? In the case of the higher plants, it would be reckoned from seed to seed. The formation of each new cell does not imply a new generation. And so, in the case of the spore-bearing bacteria, I should be inclined to reckon the generation from spore to spore, and not the mere division of the rods, which seems to me more comparable to the formation of new cells in the same generation. But if one reckon the whole cycle of changes from the sprouting of one spore to the formation of new spores as a generation, then the idea that one spore-bearing bacterium can be converted into another in a few hours or days is quite untenable.

In the case of the cholera bacillus, I doubt whether the complete cycle is known; but, so far as our information goes, it probably extends from the early stage, when the bacillus is almost straight, to the curved stage, and thence to the spirillar stage. But this cycle takes a considerable time, and the idea that a sufficient number of these cycles occur in a single case of cholera to convert one organism into another is quite out of the question. But, even granting that the formation of each new cell is a generation, there is still not time for conversion of one organism into another. Take case No. 2 as an example. Here, in 24 hours from the first symptoms of the disease, there were already innumerable myriads of cholera bacilli in the dejecta; hence, on the view we are considering this change must have occurred a considerable time previously; in fact, within a very few hours of the commencement of the choleraic process, in a period of time too short, so far as we can judge, for the occurrence of change. And, then, again, the cholera bacillus can be grown through a large number of generations extending over months, and it does not show the slightest evidence of change. My own cultivations retain precisely the same characters as when they were first obtained five months ago. And yet, if this organism be so very unstable that a few hours in a cholera patient suffice to change its characters, one would expect that it would again revert to its original characters, more especially as it has been grown under a great variety of conditions. The attenuation of anthrax bacilli is not a case in point, as there is no alteration in form and other characters, but only loss of pathogenic properties. The only instance which could be adduced is Buchner's experiments, in which he thought that he had converted the innocent hay-bacillus into the virulent bacillus-antracis and, vice versa; but these experiments have been repeated by various observers, amongst others by Dr. Klein, and the conclusion come to was that Buchner's results were due to accidental contamination of his cultivations, and not the conversion of one organism into another; and Dr. Klein has published a number of other observations on other bacteria to show that a change of this kind does not occur. But I need not refer further to this view, against which all experimental evidence is unanimous, and in support of which no reliable facts are known.

We are then left with the other alternative, namely, that, so far as our present knowledge goes, there is no other probable explanation of these two leading facts than that the cholera bacillus is in some way or other casually connected with Asiatic cholera. There are, moreover, various other facts which favor this view, in addition to the difficulty of finding any other probable explanation of the exclusive association of this organism with Asiatic cholera.

According to Dr. Koch, these organisms are present in greatest numbers in the most acute cases of the disease, and at an early stage. In the cases previously mentioned, it will be seen that they were most numerous in the dejecta from a case only ill 24 hours, and least numerous where the patient had been ill for 4 days and was recovering. Again, the experiments on

animals show that, when this organism can grow in the intestine it sets up a morbid process similar to cholera. In my own experience, two definite cases of this kind occurred, and I have previously hinted that we will shortly have very striking evidence from Dr. Koch on this point. In fact it seems as if he had found out why it is that injections performed in the way I have previously described are so uncertain; and apparently, as I understand, he can now infect the animals with certainty with pure cultivations of the cholera bacillus. I need not, therefore, enter into this matter of experiments on animals, for Dr. Koch's further report will be published soon. Again, this organism is remarkable for the rapidity with which it is killed by drying; and Mr. Macnamara mentions, in his work on Asiatic cholera, that during the epidemic spread of the disease districts suffering from drought were entirely passed over, although small-pox and other epidemics were raging freely in them. Again, Mr. Macnamara states, as the result of his precise observations, that dilute acids—the gastric juice, for example—kills the virus of cholera; gastric juice, as we have seen, kills the cholera bacillus very rapidly. He also came to the conclusion that decomposition destroys the virus of cholera, and Dr. Koch came to the same conclusion with regard to the cholera bacillus. Then the way in which epidemics disappear from Europe would imply that the virus can not be very tenacious of vitality; the cholera bacillus has no spore or resting stage, and soon dies when it has insufficient nutriment.

But while there appears to be every reason for believing that without this bacillus Asiatic cholera could not occur, it is evident that this disease is one in which other factors play a most important part. It remains to be ascertained whether this bacillus stands on the same footing as other pathogenic bacteria—say, the bacillus anthracis. Inject anthrax bacilli into an animal, and they will practically, with certainty, cause anthrax. Is the cholera bacillus equally potent? What is the meaning of the epidemic outbreaks of this disease, and why is it at times endemic without being epidemic? In fact, what other conditions come into play, and what is the importance of the share they take in the causation of the disease? That other conditions do play a very important part, is evident from the whole history of cholera, and I can only explain the great, and apparently hopeless, diversity of opinion among Indian observers, as to the contagiousness of the disease, by supposing that one observer has paid special attention to one set of conditions, and that another must have been specially struck by other conditions. These are the points which, it seems to me, now urgently require investigation; for, till some conclusion is come to as to all the necessary conditions concerned in the process, we can hardly expect to be able to decide on the best and most practicable means of prevention and cure, although, no doubt, the knowledge gained by Dr. Koch's work must greatly advance matters.

Dr. Emmerich (see *Deutsche Medicinische Wochenschrift*, No. 50, 1884) found, by cultivation, a short thick bacterium in the blood and internal organs in cases of Asiatic cholera which he thinks has a better right to be looked upon as casually connected with the disease than have Koch's cholera bacilli. This research has been criticised at length by Professor Flügge in the *Deutsche Medicinische Wochenschrift* for January 8, 1885; and I need only repeat one or two of the points in Professor Flügge's criticism, which seem to me to be justified. Emmerich considers that the reason why other observers have failed to find micro-organisms in the blood and tissues is that too few cultivations have been made in each instance. If, however, only a certain proportion of the tubes show growth, it would imply, in Flügge's opinion, the presence of relatively very few organisms in the whole circulating blood, while on Emmerich's view the blood is the seat of the disease, and therefore ought to contain large numbers of organisms. Then Emmerich leaves out of sight the possible accidental contamination of some of these tubes during the process of inoculation, and also the possibility that the organisms may have penetrated into the blood and organs after death. Flügge further points out that Emmerich did not employ the glass plate cultivations in Naples, but merely inoculated tubes, and took them back to Munich, where the plate cultivations were first made. This was, of course, a totally inadequate method. Dr. Emmerich apparently saw the weakness of this method, but considers the objection invalid, because it was the same organism which devel-



oped in each tube. But Professor Flügge points out that the form and mode of growth of these organisms on nutrient jelly is by no means characteristic, and that many of the commonest accidental impurities of cultivations are alike, or very similar, in their form and mode of growth. Emmerich found that, when he injected cultivations of these organisms into guinea-pigs—into their intestine, lungs, or subcutaneously—an affection of the small intestine ensued, corresponding in severity to the quantity of material injected. There was either simple catarrh or exudation with swelling of Peyer's patches, or extensive ecchymoses and formation of ulcers, which in some cases led to perforation. In the cæcum and large intestines there were also, at times, extensive ecchymoses. The peritoneum was injected, mesenteric glands swollen, spleen small and soft. Flügge points out, in connection with this, that these are not the post-mortem appearances of Asiatic cholera in man; that Emmerich evidently only obtained it with a certain proportion of the cultivations which he brought from Naples; and that similar results follow the injection of a bacillus which has nothing to do with the cholera, and which Dr Kreibohn obtained in Flügge's laboratory from human sputum and saliva. I need not pursue the criticism of Emmerich's investigations further, more especially as most other observers who have worked out the matter are agreed that no micro-organisms are present in the blood or internal organs in Asiatic cholera; but I may end by quoting one sentence from Flügge's criticism. He says: "As a matter of fact, the state of matters is this, that Emmerich could have obtained all his results—his cultivations, the characteristics of the organisms cultivated, and the infection of animals—if he had investigated any dead body, not too long dead, which had nothing whatever to do with Asiatic cholera."

I must now pass on to Dr. Klein's statements, based on the result of the researches of the English commission, and also of his own work since the return of the commission. This is by far the most complete of the researches which are opposed to Dr. Koch's views, and both on account of Dr. Klein's high reputation and of the immense importance of the subject, it requires careful and thorough criticism. This research is stated by Dr. J. M. Cunningham, sanitary commissioner with the government of India, to be "entirely subversive of the statements advanced by Professor Koch, as to the so-called 'comma bacillus' being the cause of cholera." This is a most serious conclusion, and being the view taken by a high authority in India, and being nevertheless opposed to the weight of evidence, it is the more necessary to analyze Dr. Klein's statements very carefully, so as to be certain that there has been no possibility of error.

In the preliminary report of the English Commission, dated November 27, 1884 (British Medical Journal, January 3, 1885), the first statement runs as follows: "The statement of Koch that 'comma bacilli' are present only in the intestines of persons suffering from, or dead of, cholera is not in accordance with the facts, since 'comma bacilli' occur also in other diseases of the intestines, for example, epidemic diarrhea, dysentery, and in intestinal catarrh associated with phthisis." Now, if by the expression "comma bacilli" is meant cholera bacilli, and it ought to mean this, otherwise it is not an argument, this statement, if correct, is, as Dr. Cunningham puts it, "entirely subversive of the statements advanced by Professor Koch as to the so-called 'comma bacillus' being the cause of cholera." And this statement is not only subversive of the view that the cholera bacillus is the cause of cholera, but also renders it impossible to consider the presence of this bacillus as diagnostic of Asiatic cholera; hence, doubtless the reason why no mention is made of this most important fact in the reports of the English Commission. This statement, if correct, would further imply great carelessness on Dr. Koch's part, in not having ascertained this fact during the months which he spent on his investigation, a fact apparently readily made out in a few weeks by the English Commission.

At the meeting at the Royal Society on February 5 (British Medical Journal, February 7, 1885), Dr. Klein repeated and extended this statement. He there said, "Koch overlooked the fact that 'comma bacilli' occur in other intestinal diseases, in the mouths of healthy persons, and, as shown recently, even in some common articles of food (by Dr. Deneke in stale cheese)." And at the meeting of the Royal Medical and Chirurgical Society, on March

24, the same statements were repeated without any qualification whatever. When, however, we call to mind that similar materials were thoroughly examined by Dr. Koch in India, with an entirely negative result, and when the negative results obtained by other observers, as described in the preceding pages, are taken into consideration, the question naturally arises whether this statement may not be really founded on a misapprehension of what Dr. Koch meant by cholera bacilli. If by "comma bacilli" Dr. Klein meant "comma-shaped bacilli," and therefore not necessarily cholera bacilli; if, in other words, he relied on microscopic appearance alone, and not on the cultivation characters for the determination of cholera bacilli, the whole discrepancy is explained. It turns out now that this was really the case, for in the *British Medical Journal* of April 4, 1885, Dr. Klein publishes "some remarks on the present state of our knowledge of the comma bacilli of Koch," in which he devotes a considerable amount of space to the attempt to show that the discovery of the comma bacilli, "their description and their specific relation to cholera were asserted by microscopic examination only," and in which he tells us that "there is nowhere (in Dr. Koch's reports) a word of a culture test."

I was able, in a letter in the *Journal* on April 11, to show that, in this supposition, Dr. Klein was entirely wrong, and to this I must refer the reader. I only quote Dr. Klein's statements here to show the view which he held as to the methods used by Dr. Koch in distinguishing the cholera bacillus. Thinking that Koch discovered, described, and asserted the specific relation between cholera and these bacilli by the microscopic appearance alone, the English commission naturally proceeded to examine other materials by the microscope alone, and, finding comma-shaped bacilli, looked on this result as entirely subversive of Dr. Koch's statements. Had Dr. Klein not considered that the microscopic examination was sufficient, he could hardly have referred to Deneke's cheese spirilla in the passage I have quoted from the meeting at the Royal Society, for Dr. Deneke's paper is entitled, "On a new form of bacterium resembling the cholera spirilla," and in it Deneke points out how this new bacterium may be distinguished from the cholera bacillus. Regarding this as the only explanation of Dr. Klein's statements, I suggested that Dr. Klein should tell us in what cases the results were obtained by microscopical examination alone, and in what cases the statement rested on culture tests as well. The result of this was that, in the abstract of his remarks, published three days later (*British Medical Journal*, March 28, 1885), he says: "Comma bacilli of various species have been discovered in other diseases of the alimentary canal, in the fluid of the mouth of normal persons (Lewis), and in old cheese (Deneke). The comma bacilli found by Finkler and Prior in cholera nostras, differ in mode of growth from Koch's comma bacilli of cholera; so do those found in diarrhea due to other causes; but those of the fluid of the mouth are identical with Koch's comma bacilli in many respects." And, in the later paper to which I have already referred (*British Medical Journal*, April 4, 1885), in which Dr. Klein gives his views as to "the precise position with regard to the comma bacilli of Koch," no mention whatever is made of the comma bacilli found in other diseases of the intestine. In reality, the facts stated as result No. 1 of the preliminary report, instead of being "entirely subversive" of Dr. Koch's statements, do not affect the question at all, for the simple reason that the bacilli found in these cases were not cholera bacilli.

The only matter which Dr. Klein now brings forward against the cardinal point of Koch's research (that the cholera bacilli are found only in Asiatic cholera), is the case of the salivary bacillus. This was not mentioned in the preliminary report at all, but was first spoken of before the royal society. At the meeting at the Royal Medical and Chirurgical Society, I referred to the failure on the part of numerous observers, to cultivate the comma-shaped bacilli of the saliva, although the same material and methods were used as were being successfully employed for the cultivation of the cholera bacilli; and I also said that Dr. Klein was the only observer who thought that he had succeeded in cultivating them. Dr. Klein then stated that the salivary comma bacilli would not grow on the same soil as was used for the cultivation of the cholera bacilli, on which I naturally suggested that that proved that they were not the same organisms. To this view Dr. Klein assented.



In the *British Medical Journal* of March 28, 1885, Dr. Klein tells us that he obtains his cultivations of the salivary bacilli in neutral jelly ; and that, after one or two generations they will grow in the alkaline gelatine ; and he says that the comma bacilli of the mouth are identical with Koch's comma bacilli in mode of growth "in many respects." In the later paper of April 4, however, he tells us that after acclimatization in neutral media, the salivary bacilli "present the same appearance of growth as the choleraic comma bacilli." He says also that the cholera bacilli, under varying conditions show similar variations and instances the following : "When the choleraic comma bacilli are mixed with hydrochloric acid (1 to 1,000), from 10 to 15 minutes, and when after this they are sown in alkaline nutritive gelatine they do not grow at all, or only with great difficulty ; but on sowing them, after the treatment with the hydrochloric acid, in alkaline broth they grow well and then transferred to alkaline nutritive gelatine they show copious and typical growth." This result is, however, not a case of acclimatization at all, as will be seen by reference to my experiments with acids ; had glass-plate instead of test-tube cultivations been made in the first instance, it would have been found that the bacilli grow as readily in the alkaline gelatine as in the meat infusion, the result in the test-tube cultivations simply depending on the acid being carried along with the bacilli, and impeding or preventing their growth. I may say here that as the result of his experiments with 1 to 1,000 hydrochloric acid, Dr. Klein states that these bacilli are not killed by acids. This however entirely depends on the strength of the acid employed, acid of the strength of the gastric juice killing them, as I have previously shown, very rapidly. It would be interesting to know whether Dr. Klein's dilute acid (1 to 1,000) was one part of the commercial acid to 1,000 parts of water or whether it was made up on Dr. Brunton's formula. If it were the former, then his results entirely correspond with mine ; but in any case, they do not bear in any way on this question of acclimatization of the salivary bacillus.

Returning now to the salivary bacillus, is it a fact that it will grow in neutral jelly containing 5 or 10 per cent. of gelatine ? I have stated in my report that I have failed to cultivate it in this material, and, as I have said, other observers have had like bad success. In order to go into this matter thoroughly, and, after numerous experiments, I am satisfied that the salivary comma bacilli will not grow in this material. Of course, before Dr. Klein's view on the acclimatization of the salivary bacillus can be accepted, or even discussed, he must give us a method by which any one with sufficient skill and experience in these matters can repeat his observations. Dr. Koch told us how to cultivate the cholera bacillus, and his observations can be readily verified by any one. Dr. Klein has told us how he thinks he has succeeded in cultivating the salivary bacillus, but his experiments cannot be repeated. He has not told us on how many different occasions, and on how many different individuals he has repeated his observations. Is he perfectly certain that there could not have been accidental contamination of his materials with cholera bacilli ? If Dr. Klein will go to some other laboratory, such as at Oxford or Cambridge, leaving behind him all cholera cultivations, instruments, etc., so as to avoid the chance of accidental contamination, and if he will there prepare fresh material and obtain cultivations of salivary bacilli, identical, in all respects with Koch's bacilli after acclimatization in whatever medium he chooses, and will further describe a method by which his results can be repeated, then the matter can be further discussed. But unless that be done, my conviction is that the explanation of his experiments is the same as that which he gave of Buchner's similar experiments with anthrax and hay bacilli, and the same as the explanation of the old experiments on the artificial production of tuberculosis, namely, accidental contamination.

That I am not making any improbable suggestion is evident from Mr. Dowdeswell's research, published in the *British Medical Journal*, March 21, 1885. Mr. Dowdeswell there tells us that "in separating some other microbes by fractional cultivation in gelatine," he found that he "had accidentally got a growth of typical comma bacilli, as far as shown by the characters of the colonies on the surface of the gelatine." Mr. Dowdeswell thinks that the contamination in this case comes from the air. Although I think that there are very grave reasons against the view that the contamination in this case came from the air—in

fact, I do not feel inclined to accept this explanation without further proof—nevertheless, the observation is extremely interesting and important, as showing that an observer working in the Brown institution, and with Dr. Klein's methods, is not safe from accidental contamination of his cultivation with comma bacilli, if cultivation of cholera bacilli are being carried on at the same time and in the same place.

I may now pass on to the second statement in the preliminary report, which is the following: "The 'comma bacilli,' in acute typical cases of cholera, are by no means present in such numbers and with such frequency as to justify Koch's statement, that 'the ilium contains almost a pure cultivation of comma bacilli.'" This statement is reiterated in the several communications to which I have referred. The amount of importance to be attached to this observation entirely depends on the manner in which it is made; and there is no statement that it was an observation as the result of cultivation, but rather as a result of microscopic investigation. The same error of dependence on microscopic characters is evidently at the foundation of this statement as was at the root of the first proposition. I have in my report sufficiently pointed out the fallacy of microscopic observation alone, and I need not go over the ground again. Dr. Gibbes, it is true, referred, at the meeting of the Royal Medical and Chirurgical Society, to cultivation in these cases, but he only referred to test-tube cultivations; there was no mention of estimation by these glass-plate cultivations. Dr. Gibbes told us that when a number of tubes were inoculated from the contents of the intestine in an acute case, the resulting growth, in the majority of instances, contained only a few cholera bacilli. But, from the results of test-tube cultivations, one can not gain any idea of the relative numbers of organisms present in the original material. For the organisms which finds the nutritive material the most suitable soil for its growth will grow most rapidly, other conditions being favorable, and will very soon be present in greatest numbers, even though it may not have been the most numerous form in the material originally introduced. In fact the cholera bacilli seem very readily to disappear from many mixtures of different bacteria. This observation with regard to the numbers of bacilli in acute cases is entirely opposed to my own experience as narrated before, and to the experience of others who have worked with the glass-plate method. In any case it is by no means the most important point, the necessary questions being the constant presence of this bacillus in cholera and its absence in other instances.

In connection with this matter, I may also refer to Dr. Klein's observation on the tank in which he found "comma bacilli," although a number of persons were drinking this water without becoming affected with cholera. The question again naturally arises: was it the cholera bacillus which was present in the water? Was the microscopic appearance alone trusted to, or was cultivation used as a test? If this statement rests solely on microscopic observation, then we cannot consider the matter further, because we do not know that we have here to do with the cholera bacillus. The same error vitiates this question as vitiated the former two. But even if we suppose that in this instance it was the cholera bacillus that was present in the tank, the observation does not prove that these bacilli are not the cause of cholera. As I have pointed out already many conditions come into play in connection with an attack of cholera. For instance, whatever be the virus of the disease, why does it apparently at times lie more or less quiescent, and then suddenly lead to epidemic outbursts of the disease? Why does one epidemic differ from another in virulence, etc.? But, apart from conditions affecting the virus probably outside the body, there are conditions in the body which may or may not predispose to an attack. Take tuberculosis for example. There is every reason to believe that the inhalation of tubercle bacilli will, in man as in animals, under suitable circumstances, set up a tubercular process. And yet we probably all have inhaled tubercle bacilli at some time or other without becoming tubercular. Two conditions at least evidently influence this. Thus, for one thing, the tubercle bacilli may never reach, or be able for mechanical reasons to settle in, a suitable part; or, in the second place, reaching such a part—say the air vesicles of the lung—they may not find a suitable soil on which to grow. Or, take a case about which there can be no dispute—anthrax—we know that probably according to the state of the individual, one may escape after inoculation with anthrax bacilli, another may have a mild pustule, another a severe one, and a fourth an acute fatal disease. So in this



case, apart from the degree of virulence of the organism, the bacilli in the water may never have reached the necessary seat—the intestine—or, reaching it, may not have found it a fit soil. For these various reasons I do not think that much importance can be attached to this observation; and I see that Dr. Klein omits it altogether in his last statement on the “precise position with regard to the comma bacilli of Koch.”

The third statement in the preliminary report is that “comma bacilli are not present in the tissues of the intestine or elsewhere.” What is meant by “elsewhere” is not clear, but I presume it refers to the blood and various organs. This same statement is reiterated in the various other places to which I have referred. I have previously mentioned the fact that Koch and others have found considerable numbers of these organisms in the tissues of the lower part of the ileum, more especially in the neighborhood of Peyer’s patches, in acute cases in which the post-mortem examination was made very soon after death. I have also narrated my own failure to find these organisms in the tissue, and give a possible explanation of it. The same explanation is probably applicable to Dr. Klein’s results. In any case, it does not seem to me that this matter touches the question of the casual relation of these bacilli to Asiatic cholera. Dr. Klein seems to make a very strong point of this, and to think that his failure to find the bacilli in the intestinal wall is sufficient to fatally affect Dr. Koch’s view of the casual relation of these bacilli to Asiatic cholera. It seems to be the thought that the choleraic virus acts by producing a poison, and that, unless the organisms be present in the intestinal wall, any poison formed by them could not be absorbed. Dr. Klein himself said at the meeting of the Royal Society (British Medical Journal, February 7, 1885) that “Koch’s theory as to the comma bacilli present in the mucous membrane secreting a chemical poison inducing the disease can not therefore be correct.” Here two views are confused together—in fact, a third view is being tacked on, to which Dr. Koch never gave expression. Dr. Koch says that the cholera bacilli are the cause of cholera because they are always present in the contents of the intestine, and are never found in other circumstances than in association with Asiatic cholera. Then he says, accepting the view that they are the cause of the disease, “I think that they probably act by producing a poison which is absorbed and which gives rise to the symptoms.” And then the view is tacked on to this, that it is while growing in the wall of the intestine that they produce this poison, a view to which Dr. Koch never gave utterance. All that is essential for Koch’s view that the cholera bacilli are the cause of cholera is their constant presence, and it does not matter for this view whether the cholera bacilli are present in the walls of the intestine or only in its contents, so long as they are constantly present somewhere or other in the affected part. The idea that they act by producing poison, which is absorbed and gives rise to the symptoms, though probable, is a mere working hypothesis, and may have to be modified according as fresh facts are made out, without in any way invalidating the main position that the cholera bacilli are casually related to the cholera. Nor, even if it were necessary for this view that a poison should be formed, does it follow that it could only be absorbed if formed in the wall of the intestine and not in the intestinal canal.

In the British Medical Journal for April 4, 1885, Dr. Klein states that in several typical rapidly fatal cases the whole of the small intestine “presented an uniform appearance; the alterations extended equally to the whole small intestine. But in these cases there was no comma bacilli present except in the lower part of the ileum, and here they were present in very small numbers indeed, the post-mortem examination having been made very soon after death.” This statement is entirely opposed to the results which I obtained in case No. 8, in which I examined the contents of the middle part of the jejunum as well as the lower part of the ileum, and did not find any marked difference in the number of cholera bacilli present in the two places. Nor does Dr. Koch in his reports state that cholera bacilli are only present in the contents of the intestine at the lower part of the ileum, though he has found them in the mucous membrane only in that situation. The same error of dependence on microscopic appearances alone renders it impossible for us to accept Dr. Klein’s observation.

We now come to the fourth statement in the preliminary report. “The ‘comma bacilli’ in artificial cultivations carried out by one of us (E. K.) do not behave in any way differently from other putrefactive organisms.”

The exact meaning of this statement was for a long time quite unintelligible to me. There are, I think, at least two distinct views implied here: (1) That the cholera bacillus is a putrefactive organism—the word “other” implies that; and (2) that there is some common mode of behavior of putrefactive organisms in artificial cultivations. As regards the first point it is, of course, very difficult to define what is meant by a putrefactive organism, but I should define it as one that produces or aids in producing putrefaction. In this sense I deny that the cholera bacillus is a putrefactive organism; it produces at most a slightly faecal odor, and is never found in putrefying materials. In connection with the second view, Dr. Klein says, in a letter to the *British Medical Journal*, on January 24, 1885, “That any one sufficiently familiar with cultivations of the various species of putrefactive bacteria in solid media knows that almost every species—and even one and the same species cultivated in different media—exhibit peculiarities of its own, which in many instances are so marked that an expert is able to distinguish them even with the unaided eye.” There is no mention here of any character in cultivation peculiar to all putrefactive organisms which is also possessed by the comma bacillus; on the contrary he says, “anybody who has the opportunity and skill to make pure cultivations of these” (the cholera) “organisms in gelatine can not fail to find that Koch’s description of the peculiar behavior of a comma bacilli under these conditions is, in all its details, absolutely correct.” The first light which I got on this matter was from the sentence which followed the above: “But to conclude from this peculiar behavior of Koch’s comma bacilli in gelatine, and from the manifest differences existing in this respect between them and Finkler’s comma bacilli, that the comma bacilli of Koch’s are not putrefactive, but specific organisms, is a proposition which is as unsound in logic as it is incorrect in fact.” At the meeting at the Royal Medical and Chirurgical Society, Dr. Klein made his meaning quite clear by telling us that Dr. Koch considered that these organisms were pathogenic, because, among other reasons, they grew in a particular manner on nutrient jelly. Indeed, at the Royal Society the same view had been stated (see *British Medical Journal*, February 7, 1885). There Dr. Klein says, “on account of their constant occurrence in the intestines of patients suffering from Asiatic cholera, on account of their absence in all other diseases of the intestine, and on account of their peculiar mode of growth in nourishing gelatine, Koch claims for these comma bacilli not only an important diagnostic value, but also considers them as the true cause of cholera.” How such an idea could have arisen it is difficult to imagine, for Dr. Koch never said nor even supposed that they were pathogenic because they grew in a special manner on nutrient jelly. I am not aware that in the case of any organism, however virulent, it would be possible to say, from the appearance of the cultivation, that the organism would prove on trial to be or not to be pathogenic. Certainly such an idea has never been entertained by Dr. Koch, nor so far as I know by any of his followers. Dr. Koch lays stress on the cultivation characters of this organism as furnishing a means of distinguishing it from other organisms, and not as affording an argument in favor of its pathogenic nature. I pointed this out at the meeting of the Royal Medical and Chirurgical Society, and I see that Dr. Klein does not bring this forward as an argument against Dr. Koch, in either of the two papers which he has published since.

The two errors, then, which, in my opinion, lie at the root of the work of the English commission are, first, that, acting on the idea that Koch diagnosed the cholera bacilli by the microscope alone, they proceeded to investigate the matter by microscopic examination; and secondly, that seeing the stress which Dr. Koch laid on the cultivation appearances, they concluded that he meant to say that the organism was pathogenic, because it grows in a particular manner, and therefore they naturally proceeded to inquire whether the appearance of the cultivations, as compared with cultivations of other bacteria, could warrant this conclusion, and, of course, they found they could not.

I need not go into detail on the other matters in Dr. Klein’s researches, because they are of very secondary importance; but it may be well if I briefly refer to two points. The fifth statement in the preliminary report is this: “Mucous flakes of the ileum, taken out soon after death from typical acute cholera, contain numerous mucous corpuscles, many of them filled



with peculiar minute straight bacilli. The same bacilli occur also outside the mucous corpuscles. They are never missed, even where the 'comma bacilli' are." After thinking over this matter in connection with my own experience, and after seeing Dr. Klein's specimens at the meeting at the Royal Medical and Chirurgical Society, I ventured to suggest at that meeting that it was possible that these bacilli are only young cholera bacilli, and I thought so for two reasons. In the first place, it is precisely in these mucous flakes that one finds, on cultivation, that the largest numbers of the cholera bacilli are present, while on microscopic examination there may, as Dr. Klein says, appear to be very few of these organisms; hence some of the forms in which the curve is not very marked must also be cholera bacilli. And, in the second place, the specimen which I saw at the meeting looked very like a specimen of young cholera bacilli. Of course, I know that the reply to this is, that Dr. Klein has cultivated these bacilli, and has found that they are not cholera bacilli. My answer to that is that, without doubt, Dr. Klein has cultivated small straight bacilli from the contents of the intestine, but that is no proof that the small cultivated bacilli were derived from the bacilli seen in the mucous corpuscles; it is impossible to make a cultivation from a single mucous corpuscle without getting at the same time the other bacteria which are present in the contents of the intestine. Small straight bacilli, similar in growth to those exhibited by Dr. Klein, can be cultivated from the contents of normal intestines, and would naturally be present in the contents of a choleraic intestine. After all, it seems to me that these straight bacilli do not deserve the attention they have received, for Dr. Klein has never said that they only occur in the intestine in Asiatic cholera, and, unless that can be demonstrated, they evidently have no real connection with the disease.

Dr. Klein also attributes the results in the successful cases of inoculation of cholera bacilli to septicæmia or to the effects of the operation. The former idea is incorrect, because the operations both in Dr. Koch's cases and in mine were performed strictly antiseptically; and in the guinea-pigs in my case there were no bacteria in the blood and tissues. Dr. Klein refers, as a similar example, to fatal epidemics of diarrhœa in rabbits in which there are no bacteria in the blood or internal organs. Of this I am quite aware, and it was to an epidemic of this kind that I referred in series 1 and 2 in my report on micrococci in relation to wounds, etc. (*British Medical Journal*, September 20, 1884.) But the animals on which I experimented with cholera bacilli in the way described were guinea-pigs, and they are not, so far as I know, subject to similar epidemics. I have never operated on rabbits, because I understood that they were quite refractory to the cholera bacillus.

From what has been said it will be evident that no facts have been brought forward in opposition to Dr. Koch's research which can bear criticism. Dr. Koch's facts remain now as correct as when he first published them. He said that this organism was constantly present in Asiatic cholera, and that it was present nowhere else. These statements have now been amply confirmed; and it is perhaps the most striking evidence in favor of the precision of Dr. Koch's methods, and of the care which he has devoted to the subject, that though other bacilli of somewhat similar appearance have since been discovered, yet, by the use of his methods, it has been found easy to distinguish them one from another, and from the cholera organism.

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*KOCH'S OPINIONS AS EXPRESSED AT THE SECOND CHOLERA CONFERENCE AT BERLIN, 1885.*

Only in the direction of experiments on animals has an advance been made; since Nicati and Rietsch have succeeded in infecting dogs and guinea-pigs by injection of choleraic intestinal contents and cultivations of the comma bacilli into the duodenum. These experiments have been repeated and confirmed here in the Sanitary Institute as well as by Babes, Flügge, and Watson Cheyne. Rietsch and Nicati at first believed that the infection could only take place if the bile were excluded, and therefore they ligatured the ductus choledochus, but they

found later that the experiment would succeed without such ligature. Our experiments also were carried out partly with and partly without ligature of the ductus choledochus, and gave the following results: Of 10 guinea-pigs operated on with ligature of the gall duct and injection of the cultivations of the comma bacilli into the duodenum, 6 died of cholera in the first two days; the rest died later, in consequence of the ligature. You see here, preserved in alcohol, the abdominal organs of such a guinea-pig, which survived the infection, but rapidly wasted, and died on the ninth day after the operation. The gall-bladder is enormously distended, as well as the ductus choledochus above the point of ligature. No trace of peritonitis is to be observed in this case. In another guinea-pig, which died twelve days after the operation, the gall-bladder was ruptured, and the peritoneal cavity filled with bile. The two remaining guinea-pigs perished from twisting and obstruction of the intestine, in consequence of peritonic adhesions in the immediate neighborhood of the point of ligature. In these experiments it soon struck me that the better these operations were performed and the less severe the manipulation, so much the less was the prospect of the death of the animal from cholera.

Of 18 animals which had only an injection into the duodenum, without ligature of the bile duct, 13 died of cholera. At the same time also control experiments were made by the injection of other kinds of bacteria, such as the micrococcus prodigiosus, different kinds of bacilli, etc., into the duodenum of guinea-pigs. Of these animals, in which the ligature of the gall duct was omitted, not one died. This showed that the operation is not of itself dangerous to the animal. Klein declared that the guinea-pigs died in these experiments, not of cholera, but of septicæmia. But, according to my experience, the danger of septicæmia in this extremely simple operation may be excluded with certainty. One must set to work very awkwardly to lose any of the animals from that disease.

In the experiments done without ligature of the gall duct, the results were also the less positive the less severe the operation, and the less the intestine was bruised and stretched by the search for and dragging out of the duodenum. On this account, also, the experiment only succeeded occasionally when one contented oneself with opening the peritoneal cavity only to a slight extent, and with injecting the material, not into the deep-lying duodenum, but into the loops of the small intestine which first came into view. Of 6 guinea-pigs which were operated upon in this manner only one died of cholera; the rest lived. Then the same experiment was made on 4 rabbits, without one of them dying or even becoming ill.

Now, though, by means of the injection of the comma bacilli into the duodenum in animals a process analogous to cholera in man may be set up in the digestive tract, one must nevertheless allow that this mode of infection corresponds very little to the natural process. It is by no means a small matter to open the peritoneal cavity and search for and draw out the duodenum, in order to introduce the infective material into this part of the intestine. I have on this account endeavored to infect the animals in a natural manner, and have been finally successful. It appears to me not unimportant to describe the way by which I was at last led to a positive result. The earlier experiments had already shown that the comma bacilli are killed in the stomach, for if the animals are fed on choleraic fluids and cultivations and killed after some time, no comma bacilli can be found in the stomach and intestine; they have been destroyed in the stomach. But the non-appearance of the infection could not be due to this alone, for in the injection into the duodenum the gastric digestion is avoided, and nevertheless the infection did not always succeed. Now, in order to get an insight into the conditions which come into play, I have made a number of preliminary experiments, and as guinea-pigs appear to be particularly susceptible to the cholera infection, I have confined myself to these animals. First of all, I endeavored to find out somewhat more minutely the natural digestive arrangements in guinea-pigs. If a freshly-killed guinea-pig is examined, the stomach is always found completely crammed with a firm mass of food; so that if anything, for example a fluid, is introduced into the stomach, it cannot pass through it directly. I had at first thought that if a large quantity of fluid containing bacilli was injected into the stomach at one time it might be possible to force some through it. But I convinced myself very soon that this was quite impossible, and that the stomach would burst before the solid firm mass which distended it could be forced aside. The small intestine in guinea-pigs in



contrast to the stomach is almost empty. The gastric contents are strongly acid, the mucus-like contents of the small intestine alkaline, while the contents of the cæcum, which is very large in these animals, have again a markedly acid reaction; so that it is only in the small intestine that an opportunity is afforded for the comma bacilli to grow and multiply. In order to find out something about the length of time which the ingesta take to pass the stomach and intestine, guinea-pigs were fed alternately with different kinds of food, as, for example, with carrots and hay. In animals which were killed in one or two hours after the change of food, one saw that the foods had not become mixed in the stomach, as occurs in digestion in man, but had been slowly pushed through it in layers, in the order in which they had been taken, so that on a sharply defined dark green layer of hay there followed a red layer of carrots, or *vice versa*. The foods then pass surprisingly quickly through the small intestine to the cæcum. This was demonstrated very clearly by feeding with colored materials. If, for instance, a mixture of Chinese ink was injected into the stomach of the animals, one could follow and notice still more accurately the stratified progress of the food; and the coloring material, as soon as it had passed the pylorus, was found in a very short time in the cæcum. The same experiment was made with small blue glass beads, when it appeared that the beads traversed the stomach comparatively quickly, but only with the layer of food with which they had entered; and they then very rapidly, probably in a few minutes, passed down the small intestine to lodge for a longer time in the cæcum. In one experiment, for example, 250 beads were administered, and the animal killed after 3 hours. Only about half the beads were present in the stomach; the small intestine did not contain a single one, while there was a large number in the cæcum. An experiment of feeding with the spores of the anthrax is also worthy of mention. One might assume that beads are bodies by the behavior of which in the stomach and intestine that of bacteria could not be judged. Four Guinea-pigs were therefore fed with a large quantity of anthrax spores. One of these animals was killed after  $2\frac{1}{2}$  hours, and the contents of the stomach, small intestine, and cæcum were examined for the development of the easily recognizable colonies of the anthrax bacilli by means of cultivations in nutrient jelly on plates. In this case many anthrax spores were still found in the stomach, likewise in the small intestine, and some spores had already reached the cæcum; the mass of the food also had passed through the stomach and small intestine in the short space of 2 hours. A second animal was killed after 3 hours. The number of anthrax spores in the stomach was already markedly smaller; in the small intestine they were still abundant; in the cæcum likewise abundant. The third Guinea-pig was killed after  $3\frac{1}{2}$  hours, and had in the stomach only a few of the anthrax spores, in the small intestine also very much fewer than the foregoing animal, but in the cæcum there was a considerable number. In a Guinea-pig killed after 5 hours only 1 or 2 anthrax spores were found in the stomach, a very few in the small intestine; on the other hand they were still very numerous in the cæcum.

It became apparent in these experiments that the pathogenic bacteria, which were used as food for the Guinea-pig, passed through the stomach and small intestine surprisingly quickly, nevertheless they always remained sufficiently long in the stomach to be destroyed by the gastric juice, unless they existed in a resistant resting stage, like the anthrax spores.

The next point was to enable sporeless bacteria, like the comma bacilli, to pass through the stomach uninjured. To render this practicable the fluid containing the bacilli was made up in the form of pills and covered over with keratin, and as this experiment did not lead to a positive result, other enveloping substances, which were insoluble in the stomach, were made use of, such as collodion, caoutchouc, paraffin, and so forth; but all in vain.

Thereupon I tried to neutralize the acid reaction of the stomach, if only for a short time. At first those doses of the alkaline fluid were fixed upon which could be borne without any detriment to the animal. A 5 per cent. solution of carbonate of soda proved most suitable for our purpose, and 5<sup>ccm</sup> of this solution could be imbibed by the animals without causing any disturbance. If a specimen of the contents of the stomach was taken by a fine catheter, it was found in a series of experiments that the reaction was still alkaline after three hours. When we had made out this, we proceeded to feed animals whose gastric contents had been thus made alkaline with cholera cultivations, or to inject the same through a catheter directly

into the stomach. In the first experiment 7 guinea-pigs were used. These received 5<sup>ccm</sup> of the soda solution, and some time after, so as not to bring the cholera bacilla into direct contact with the soda solution, 10<sup>ccm</sup> of meat infusion in which cholera bacteria were growing. The animals remained quite lively after this. As later also no effect was apparent, they were killed after 24 hours, and the gastric contents, the intestinal contents, and the contents of the cæcum were examined with gelatine plates. In 6 of the 7 animals the cholera bacilli were demonstrated in the small intestine. The experiment was thus so far successful, that the comma bacilli passed through the stomach uninjured, but without having produced disease in the animals. This experiment was performed over again, but in this way: Two Guinea-pigs receiving a 2 per cent. and six Guinea-pigs a 5 per cent. solution of soda and then the injection of comma bacilli. These animals also remained quite healthy, and from this result it was at least evident that it is quite a harmless procedure to introduce into the stomach of Guinea-pigs a syringeful of a 5 per cent. solution of soda. The animals were not even ill from it. Finally a third series of experiments was made on four Guinea-pigs, which first received a 5 per cent. soda solution and then the cholera bacilli. These animals likewise remained healthy. On the next day, however, one of them seemed to be ill, was out of sorts, and did not eat. On the day after it was seriously ill, and showed the very peculiar symptoms which were already known to me in animals infected by injection into the duodenum. It had a paralytic weakness of the hinder extremities, supported itself no longer on the hind feet, and in consequence lay quite flat with its legs stretched out. The respirations were weak and prolonged, the head and extremities felt cold, the heart's pulsation was scarcely perceptible, and the animal died after it had been in this condition for a few hours. It was examined immediately after death, and the most pronounced choleraic signs were found in the intestinal canal. The small intestine was deeply injected, and filled with a flocculent colorless fluid. Also the stomach and intestines did not as usual contain firm masses, but a large amount of fluid instead. Diarrhea had not occurred, and, in accordance with this, firm scybalæ were still present in the rectum. The examination by the microscope and with gelatine plates showed that the small intestine contained a pure cultivation of numerous comma bacilli. Now it is very remarkable that of 19 animals the infection was successful in one only, and this by chance in an animal which had aborted immediately before the infection. In the autopsy the abdominal walls were found to be very flaccid and the uterus still greatly enlarged. This led me to the idea that either the abortion of itself, or perhaps its unknown cause, might have acted on the other abdominal organs, and especially on the small intestine, in such a way as to produce a temporary relaxation of the intestine with cessation of the peristaltic action, and that in consequence of this the comma bacilli which were present in the intestine were enabled to remain there longer, and thus obtain a footing there. In order to produce experimentally a similar condition, alcohol, chloral, morphia, atropia, and opium were employed in the form of subcutaneous or intraabdominal injection, and it was found that opium answers best for this purpose. Opium in guinea-pigs must be employed in a special way. Incredible doses can be given internally to the animals without any noteworthy effect. Up to a certain point this circumstance may find its explanation in the distended condition of the stomach described previously. The dose of the tincture of opium which is given to the animal can not come into action at once, since at first it remains among the masses of food which the animal has in its stomach, and is only gradually absorbed. In consequence of this, an accurate dosing is not possible, and I have therefore preferred to introduce the material into the abdominal cavity of the animal by means of injection, which can be done in guinea-pigs very easily and without danger. I use opium in the form of tincture of opium, and in doses of 1 cubic centimeter to each 200 grams weight of the animal. In a short time after this dose a deep narcosis sets in, lasting from a half to 1 hour, after which the animal becomes as lively as before. Thirty-five guinea-pigs were experimented on by the administration of the soda solution and cholera bouillon, with subsequent injection of tincture of opium. Of these 30 died of cholera. The clinical symptoms and the post-mortem appearances were the same as in the guinea-pigs in which the injection had been made into the duodenum, and also in the



one mentioned previously, which had died after the administration of the soda solution and the cholera bouillon alone. If the dose of the soda solution or of the cholera fluid is reduced the result is not so certain. For example, 14 guinea-pigs were treated thus: they received 5 cubic centimeters of the soda solution, and then a fluid to which only one-third of a drop of the cholera bouillon was added. Of these animals only 7 died of cholera, the remaining 7 remained healthy. Again, in another experiment, where the dose was still more reduced, there died only 7 out of 24 guinea-pigs. On the whole up till now, 85 guinea-pigs have been infected in this way with cholera, and have died always with the same characteristic symptoms and post-mortem appearances. I shall only just mention in addition, that the infective material was transmitted successfully from one animal to another. In the place of cholera bouillon the intestinal contents of a guinea-pig, which had died of cholera, were administered to other animals, which in consequence died of cholera also.

If other bacteria are administered to animals in the same way as the cholera bacilli, with the assistance of the soda solution and the tincture of opium, very remarkable results are likewise obtained.

The Finkler comma bacilli can also destroy guinea-pigs by this mode of infection, though they are not so virulent as the cholera bacilli; for of 15 animals infected with them only 5 died. The post-mortem condition of these animals was different to that of animals which had died of cholera. The intestine was likewise largely filled with watery fluid, but it appeared pale gray. The vessels were not so markedly injected as in the cholera animals, and the intestinal contents had a penetrating, putrid smell, which corresponded exactly to the smell developed by the Finkler bacteria in nutrient jelly.

Further, the bacilli cultivated by Deneke from old cheese, which also possess a curved form, were experimented with, as also those found by Miller in a hollow tooth, which to all appearances are identical with Finkler's bacilli. Of 15 animals infected with Deneke's bacilli, 3 died; of 21 infected with Miller's bacilli, only 4.

The guinea-pigs which survived these experiments, received subsequently cholera bacilli, and the whole of them died of the cholera infection.

Pathogenic bacteria also, which, under ordinary conditions, do not act from the intestine, may produce effects when used in this manner, as, for example, sporeless anthrax bacilli and Brieger's bacteria. Other organisms, such as the bacteria of fowl cholera, of osteo-myelitis of rabbit septicaemia, and of erysipelas, fail to act even under these conditions. The bacilli of typhoid fever, which have not as yet been successfully inoculated on animals, gave a doubtful result, and on this account the experiments with them should be repeated.

I may here only mention that attempts have been made in other ways to set up in the intestine a condition favorable to the development of the cholera bacillus. For example, we gave the animals croton-oil and castor-oil, or they were fed with lees (hefe), in order to set up an intestinal catarrh. Further, we have injected into the abdominal cavity turpentine, tincture of iodine, glycerine, alcohol, etc., and thereby have had successful results. The use of alcohol was the most successful in making the animals susceptible to cholera infection, though taken as a whole the action of alcohol appeared to fall short of that of the tincture of opium.

From these experiments we can now decide that the cholera bacteria have extremely energetic pathogenic properties, and are able to show them, if they reach the small intestine uninjured, and find it in a condition which allows them to obtain a firm footing and to develop. In guinea-pigs these conditions can only be realized artificially; but in man the relations in reference to the gastric digestion are quite different to those in guinea-pigs. The human stomach is not constantly filled with strongly acid masses of food, like the stomach of our experimental animals. Probably its contents very often have a neutral or even alkaline reaction; for instance, always after the completion of the true gastric digestion and the emptying of the chyme into the small intestine.

I am indebted to Professor Ewald, who has lately been investigating this question, for some interesting communications with reference to it. He found, that if water is introduced through an œsophageal tube into the empty stomach, it remains for a considerable time

neutral, or even takes on an alkaline reaction. At the same time it was found that the quantity of water in the stomach gradually diminished—that is to say, that the stomach constantly passes on a certain quantity of its contents into the small intestine. Possibly this slow decrease was also due to absorption from the stomach. But in about an hour or an hour and a half a rapid diminution of the fluid in the stomach suddenly occurred, even before its reaction had become acid. Evidently the pylorus had then opened, and permitted the exit of the gastric contents into the small intestine in large quantities. If we were now to assume that cholera bacilli accidentally existed in this water, then they could undoubtedly have reached the duodenum of the individual in question in a living condition, and there might possibly have caused a cholera infection. An artificial preparation, as in the experimental animals, is not then necessary in order to infect man.

But it may be further concluded that, as a rule, the behavior of man to the cholera infection will not be always the same according to their condition of their gastric digestion. The different individual predisposition of man depends perhaps to a great extent upon the state of the gastric digestion at the time when the infective material reaches the stomach; and further, on what happens to be the condition of the intestine, whether perhaps it approximates more or less to the condition of the intestine of the guinea-pig after the injection of the tincture of opium. We obtain in this way a certain amount of insight into the nature of the process of infection, and I do not doubt that by means of further experiment in this direction a still greater advance will be made, and we shall perhaps be able to clear up much which is now dark to us. Since the infection of animals through the stomach has succeeded, one will be able to test experimentally the effect of drugs on the cholera process.

As I have previously mentioned to you that the cholera bacilli do not pass into the blood, we can only explain their action by supposing that they generate poisonous substances belonging to the group of ptomaines, which are absorbed and then act on the entire organism. In order to give this idea a foundation of fact I have endeavored to demonstrate directly these poisonous products of the cholera bacilli which we must suppose to exist, but these investigations have not yielded much result. Only so much as has already been made out that it is possible to prepare cultivations of the comma bacilli, which are intensely poisonous, and which, if they are injected into the animal either subcutaneously or into the peritoneal cavity, set up in a few minutes the same group of symptoms which occur in animals suffering from cholera a day or two after infection. These symptoms are the paralytic weakness of the hinder extremities, coldness of the head and legs, and prolonged respiration, a condition which usually leads after some hours to death. I should like to add to these communications a few remarks upon other experiments, which do not stand in direct connection with the experiments on infection. First, on the capability of resistance, and the durability of the cholera bacteria. On this point many investigations have been lately made by Nicati and Rietsch and by Babes. We have also again studied this question ourselves, and tried in the first place to find out how long the cholera bacteria remain alive in spring or river water, in sewer-water, in excrement, and in water from a cess-pool. Our experiments have shown that cholera bacilli mixed with spring-water could be found up to 30 days afterwards; in the Berlin sewer-water they lived only 6 or 7 days; mixed with excrement, only 27 hours; and in cess-pool water they were no longer alive after 24 hours.

Experiments were then made to try and preserve cholera bacteria for a longer time on clothing materials, such as linen cloth, etc., kept in a moist state. So far as we have as yet gone with these investigations, the result is that the capability of life of the cholera bacteria is not of very long duration. They were already dead after 3 or 4 days.

In our first conference I mentioned to you, as you will remember, the surprisingly rapid death of the cholera bacilli when in a dry state, and pointed out to you the practical importance of this peculiar circumstance. My statements at first met everywhere with doubt, but all reliable observers have convinced themselves of their accuracy, and I would at this opportunity positively reiterate them, with the request at the same time that the most extended use of this experience should be made in combating infection.



With regard to disinfection, I can report to you the result of experiments with carbolic acid. The cholera bacteria were killed in a few minutes in a solution of one-half per cent. of carbolic acid. Also sulphate of iron, sulphate of copper, and other metallic salts are active, but not nearly so sure, since a more or less large quantity of them are precipitated by some of the constituents of the nutrient solution. This would naturally make itself felt in the disinfection of cholera dejecta, and therefore I give carbolic acid decidedly the preference.

Lastly, I should like to draw your attention to an observation on the action of the cholera virus on man.

The infection of those persons who have to do with the cholera linen gives us, as already mentioned in our former conference, numerous experiences in this direction, and the last epidemic in France and Italy has afforded us many further examples. That an unintentional infection could occur through the manipulation of the cholera bacilli was not therefore improbable. In consideration of this, every precautionary regulation possible was employed to ward off this danger during the cholera courses, which were held here in the Sanitary Institute. But in spite of all our care, one case of infection nevertheless occurred, which happily ended without a bad result. Before I give more exact details of the case, I shall remind you of some investigators who have already made infection experiments on themselves. Thus Bochefontaine, in Paris, has swallowed choleraic dejecta in pills without becoming sick of cholera in consequence. Klein, according to an announcement in the Indian Medical Gazette, when he had just arrived in Bombay, drank a fluid which was said to contain cholera bacilli. Apart from the fact that in these cases it was not proved that the true cholera bacilli was present in the fluid swallowed, it stands to reason that these experiments, having a negative result, prove nothing at all; since a healthy stomach most probably destroys the bacilli during the period of digestion, and therefore it is not to be expected that if cholera bacilli are introduced into the human stomach an infection must result in every case. But if these experiments had turned out positively, they would have afforded just as little evidence, because they took place in localities where an infection could occur in other ways.

An experiment of this kind, carried out in a cholera locality, is only of real importance if the infection attacks not one single individual but a number of individuals at the same time; because the greater the number of the infected persons the less the probability that all of those who became ill were infected in consequence of an accident unconnected with the experiment. On this account I lay great stress on the instance of cholera infection reported by Macnamara, which I would bring to your recollection on this occasion.

I have corresponded about the case with Macnamara himself. The accounts of it in his work on cholera are somewhat meager; for instance, he does not state where the case occurred, nor does he give any names; however, he may have quite satisfactory reasons for not doing so. I have been always assured in Calcutta, where there was much talk about this case, that it was quite a reliable observation, and that the facts occurred exactly as Macnamara reported. He has written to me himself to the effect that he is ready at any moment to make privately further and more exact communications, which must set at rest any doubt. On this account I am convinced that everything happened as described by Macnamara, and that these observations can be scientifically made use of without any hesitation. In the Dictionary of Medicine Macnamara makes the following communication about it:

Through an accident—what kind of accident it was not stated—cholera dejecta became mixed with water. This water remained exposed to the heat of the sun the whole day, then 19 persons drank of it and 5 of them fell ill of cholera within thirty-six hours.

I am assured on special inquiry that almost no cholera prevailed at that time, and particularly at the place where the accident happened. Further, all the persons, who were familiar with the Indian conditions, to whom this case was known, and whom I asked about it, were in no doubt that these men had really become ill in consequence of the use of this water contaminated with cholera dejecta.

In our case of cholera infection observed during the cholera course, we had not to do with a wide-spread disease, but only with the infection of one individual. Nevertheless the observa-

tion is of great importance, because it occurred at a place and at a time when cholera infection, from any other source than that of the manipulation of the cholera bacilli, was absolutely excluded; and because until now it is the only case in which within the borders of Germany the true cholera bacilli have been demonstrated in the dejecta of one suffering from cholera.

The medical man in question, whose name and residence you will allow me to omit to mention, had been in Berlin for eight days, when he became affected with a slight disturbance of digestion associated with diarrhœa. The evacuations had a thin soupy appearance, and occurred several times daily, so that his condition caused him no anxiety. But on the last day of his stay more frequent thin watery evacuations made their appearance. Nevertheless he believed himself able to travel from here, did so, and arrived safely home, and then sickened with a true attack of cholera. He had for two days very frequent watery and colorless evacuations, great weakness, unquenchable thirst, and the urinary secretions were reduced to a minimum. True cramp of the calves of the legs did not show itself, but strong contraction of the soles of the feet, and spasmodic flexion of the toes occurred. As he felt himself too weak to examine his own evacuations, he placed a small quantity in a well cleaned bottle and sent it here. The vessel was sent off in the evening, arrived here on the following morning, and was at once examined. The parcel had thus been only a night on the journey, and that during a cold season of the year, so that its contents could not have altered materially in transit. The examination of the dejecta, which was made on cover glasses, and at the same time by cultivations on hollow slides and on plates, showed in each case the presence of very numerous true cholera bacilli. One of the pure cultivations exhibited to-day came from the dejecta of this patient. I shall only add that the patient got better. The diarrhœa stopped, but there remained for a long time a surprising weakness.

I must not neglect to hold up this case as a warning to those who experiment with the cholera bacilli, and who do not work with the greatest care.

Since the question of the existence of a permanent form (*dauerform*) of the cholera bacilli is still mentioned in our programme, I shall express my opinion about it in a few words. On account of the importance of the question I have been constantly endeavoring as far as possible to discover something which could be looked on as a resting stage of the cholera bacteria, analogous to the spore formation of other bacilli. But I have arrived at only a negative result, as was the case in all the earlier investigations in this direction. All statements made by other observers up till now with regard to a permanent form and spore formation depend evidently on errors. Thus for example Ceci believes that he has seen spores in the cholera bacilli. He looked on those bacilli occurring almost always in old cultivations, which, after staining by aniline, show an uncolored spot in their middle as spore-bearing. I also came across these peculiarly colored bacilli in my first cultivations, but I very soon convinced myself that the part remaining uncolored did not do so through the formation of a spore, but arose when the bacillus became thicker and coarser than usual. Probably a swelling occurs in consequence of the absorption of moisture, and a division of the plasma takes place between the thicker and more deeply colored substance found at the end of the bacillus and the less concentrated substance lying in the middle. A similar thing may be observed in the bacteria of rabbit septicæmia, which constantly take up the coloring matter, so that the middle is only slightly or not at all colored. As this appearance in the cholera bacillus occurs only in older cultivations, it must be regarded as a kind of involution or change in the dying or dead bacilli. Confirming this idea is the fact that cultivations which contain such bacilli are not in the least more capable of resisting hurtful influences, such as dryness, heat, and chemicals, than the ordinary comma bacilli. Ceci himself has found out that his apparent spore-bearing bacteria were destroyed in a very short time if they were dried. Hence, they could not have existed in a durable form.

At this opportunity I may mention as curiosities that Klein has observed a longitudinal division of the cholera bacilli, and that according to Ferrán the cholera bacilli belong to the cycle of development of a mold (*peronospora*). Both these supposed discoveries depend upon an erroneous interpretation of the forms of involution of the cholera bacillus.



Though a true resting-stage of the cholera bacilli has not yet been found, and does not even appear to exist, we are already acquainted with other facts which may explain the passing slumber of a cholera epidemic, which may last months, sometimes even a whole winter. Cholera bacilli, in contrast to their small capability of resisting dryness, can under certain circumstances remain capable of life in a moist condition for a long time. It has been already stated by Nicati and Rietsch that the cholera bacilli remained alive in the harbor water of Marseilles for 81 days. We found, on testing old cultivations which were grown in agar, that even after 144 days cholera bacilli, still capable of development, were present. In an examination after 175 days the cultivations were found, however, to be dead. Hence one can easily imagine that in superficial layers of earth, in marshes and so forth, the cholera bacilli may find conditions in which they can exist preserved from death for five months, or even longer, just as well, or even better, than on our moist agar jelly.

*\*MODIFICATION OF KLEIN'S VIEWS ON ETIOLOGY OF CHOLERA.\**

E. Klein has recently, in many most important particulars, essentially modified the opinions announced in the official report of the English Commission's work in India and London, as will be seen by the following extracts from the author's last publication (*The Bacteria in Asiatic Cholera. The Practitioner, No. 38, 1887*):

"The choleraic comma bacilli possess in artificial media certain well established characters by which they can be readily recognized. Koch has clearly pointed out this fact, and has minutely described the appearances. An idea seems to have got abroad that while in India I denied this simple truth." "To say, therefore, that such or such an organism in plate cultivation and in tubes presents such or such peculiar characters, means nothing more than that such and such an organism is of a definite species, and as we have said, the greater majority of the bacterial species are possessed of this character. I never said that the choleraic comma bacilli can not in cultivation be distinguished from other bacteria. \* \* \* I say the possession of cultural characters is not peculiar to comma bacilli. This is something quite different from saying that the cultural characters of comma bacilli are the same as those of septic bacteria."

Although Dr. Klein has reiterated much of the argumentation used in his official report concerning the morphological resemblances of various comma-shaped bacteria and has done so in such a manner as to often times render his real meaning doubtful, he admits that "the best test of distinction is no doubt that pointed out by Koch, namely, the mode of growth and the rapidity with which the two kinds of comma bacilli (he is speaking of the comma bacilli of cholera and of cholera nostras) grow in nutritive gelatine of 10 per cent. strength. The appearance of a series of gelatine tubes inoculated by means of the platinum wire or capillary glass pipette with Finkler's comma bacillus, and of another series of similar tubes inoculated in the same manner with choleraic comma bacilli and kept at 20 C from three to four days, leaves no doubt that they contain two different species."

In a later chapter concerning the diagnostic value of choleraic comma bacilli, we find Dr. Klein expressing himself as follows: "So far we have seen that various species of comma bacilli are known, and that of these the choleraic comma bacilli possess certain definite characters in cultivations on nutritive gelatine which are not possessed either by those of Finkler and Prior, Miller, Kuisl, Denecke, and Flügge, by one form of those observed in noma, or by those I have observed in the diarrhoea of man, and in the contents of the cæcum of the guinea-pig."

"One thing, however, may be said with certainty, namely, that as far as our limited knowledge at present goes, in no intestinal disorder in man have comma bacilli behaving in artificial cultures like those of Asiatic cholera been yet found in the intestinal evacuations. This of course does not mean that no intestinal disorder exists in which the same comma bacilli are not present to the same extent as in Asiatic cholera, for, as has been pointed out on a former page, our experience, hitherto, and the observations at present available, are extremely

\*The Practitioner, 1887.

limited; but there can be no doubt, I think, and in this I fully concur with Koch, that in Asiatic cholera comma bacilli can be with comparative facility detected by the microscope and by cultivation. Hence I agree to the proposition that if in any case of diarrhoea the choleraic comma bacilli can be shown both by the microscope and by culture experiments to exist, then the suspicion that it may be a case of Asiatic cholera is quite justified. And it must be clear from this that the discovery by Koch of the choleraic comma bacilli is, on practical diagnostic grounds, of the utmost importance. For if it should be found that in a locality which is in communication by sea or land with an infected country one or more cases of suspicious diarrhoea had occurred, the demonstration by culture experiments of the presence in the intestinal discharges of the choleraic comma bacilli would fully justify us in regarding such cases with grave suspicion, as being probably, though not necessarily, choleraic. At all events sanitary officers, for the sake of the public weal, would be justified in treating these cases as cases of cholera, and in taking measures of isolation and disinfection."

It is but fair to say, however, that notwithstanding all of the admissions and retractions above cited, Klein gives only an unwilling support to the claim of Koch for an absolute diagnostic value of his comma bacillus, and still strongly combats the presumption that this bacillus is also the active cause of Asiatic cholera. While abandoning his original opinion that the comma bacilli of Koch differ in no distinctive respect from the common bacteria of decomposition or from the curved bacilli of the mouth, of the intestines in various other conditions than Asiatic cholera, of the uterine discharges, etc., this author is still doubtful if a certain curved bacillus which he once succeeded in cultivating from his own mouth, and which he succeeded once in cultivating from the cœcal contents of a monkey suffering with diarrhoea, and one which he succeeded in cultivating once from a case of noma, are not biologically as well as morphologically identical with the comma bacilli of Koch. While admitting that the choleraic comma bacilli are capable of forming a deadly ptomaine which can produce many of the grave symptoms of cholera, and that it is probably through the agency of this ptomaine alone that the specific results of inoculations of the comma bacilli of Koch are brought about, yet he refuses to concede that the choleraic comma bacilli are even the probable cause of the disease with which they are so peculiarly associated, because inoculations have been so often followed by negative results, and because even when positive results are obtained they closely resemble, if they are not identical to, the effects often following the ingestion of decayed meat, vegetables, etc. A weighty answer to the first objection Dr. Klein has himself furnished, although he does not seem to fully appreciate the force of it. *Many of the negative results are explainable by the failure of the choleraic comma bacilli to produce their ptomaine*, a failure which, according to Dr. Klein, often occurs. As to the other objection, it could be said that however much various ptomaines may resemble each other chemically and physiologically, it is no more justifiable to assume from that fact their essential identity than it is to class as identical vegetable alkaloides which may have a quite similar chemical constitution or physiological effect, or to assume that pernicious malaria, cholera nostras, and cholera Asiatica are essentially the same diseases and have the same etiology because their symptoms sometimes so closely resemble each other that it is often from the symptoms alone absolutely impossible to distinguish between them.

Furthermore, when it is remembered that the Lewis bacillus was examined without resort to the culture methods now universally regarded as absolutely essential for the distinction of one species of curved bacilli from another, the assumption of Klein that the curved bacillus which he reports having found in his own mouth and cultivated with characters resembling closely those of the comma bacillus of Koch is the same bacillus which Lewis discovered, and claimed to be identical with that of Koch, should be looked upon as gratuitous and without the least evidence in its support. Again, if, in the three single instances in which Klein claims to have encountered a comma bacillus closely resembling that of Koch as to morphology and biology, he has succeeded in cultivating an organism which can not be distinguished from it, possibly its presence can be accounted for by an accident. In his book on "Micro-organisms and Disease," this author has written as follows: "During the last year I have seen the following



cases of accidental contamination occur. I work in the laboratory of the Brown Institution, which comprises a suite of rooms. Although working extensively on anthrax, I generally limit myself to one room only. A friend of mine, who one day injected into a vein of a guinea-pig blood taken from a blood-vessel of a dog suffering from distemper, found, to his great disappointment, the guinea-pig dead after 2 days under the typical symptoms of anthrax, the blood of this animal teeming with the characteristic bacilli." "Another gentleman working in the laboratory of the Brown Institution intended to inoculate several guinea-pigs with human tubercles. For this end he mashed up in saline solution, in a clean mortar, a bit of human lung studded with tubercles. He did this in my room on the same table on which I was working with anthrax. One of these guinea-pigs, inoculated with human tubercle, died before the second day was over of typical anthrax. Its blood was teeming with the bacillus anthracis. Such an accidental anthrax of a guinea-pig inoculated with tuberculous matter occurred several times." "A rabbit was inoculated with a culture of bacillus anthracis which I did not expect would produce anthrax. The animal remained unaffected with anthrax, but died after 4 weeks with the symptoms of extremely well-marked tuberculosis—in fact, the best-marked case that I have seen—of both lungs, spleen, liver, and kidney. The tubercular deposits contained the tubercle bacilli. Also in this instance inoculations with tuberculous matter had been going on at the same time, when I meant to have inoculated nothing else but a culture of anthrax bacilli.

"I think all these facts taken together prove unmistakably that working with two contagia in the same laboratory and at the same period, accidental contamination is of no rare occurrence."

Klein's criticism of Buchner's experiments concerning the convertibility of the hay bacillus into the anthrax bacillus and *vice versa*, with some change in phraseology can be very justly turned against Dr. Klein himself in the case of his curved bacilli. As for instance:

"If Klein could show us that in a laboratory, in which for some considerable time cholera cultures, cholera animals, and examinations of cholera bacilli had not been carried on, cultivation of the contents of the mouth ultimately yields typical colonies of the comma bacilli of Koch, then we should be perhaps prepared to concede his proposition concerning his three isolated observations already mentioned. Such propositions are of the widest importance, and therefore their proof ought to be beyond cavil; there ought to be no chance of a possibility of error. Such proof Klein has not given, and we cannot therefore accept them, opposed as they are to the experience of all other trustworthy investigators."

Apropos of this it should be remembered that there are already three attacks recorded of choleraic symptoms following accidental contamination in the laboratory, one of the attacks having proved fatal, and all of them having shown the characteristic comma bacilli in the stools.

Klein, while discussing the infectiousness of Asiatic cholera (*ibid.*), uses the following unequivocal language:

"It must not, however, be supposed that I mean to question the statements that cholera dejecta have produced infection, or that water contaminated with cholera dejecta has produced cholera. Such cases of infection are well established. Snow has minutely described one such epidemic—the noted Broad Street Pump epidemic—and this is only one among many noticed in former and recent epidemic in Europe. As soon as a certain impure water supply was stopped cholera cases ceased; to such a water supply—a river or well—cholera dejecta had probably had access. This question of the importance of drinking-water as a vehicle of contagion may, I think, be considered settled.

"There can be no manner of doubt that cholera infection has been started from linen soiled with cholera dejecta. These instances are notorious and numerous, and are known from former and recent cholera epidemics; they do not require any special discussion."

This author also apparently admits the production of a poisonous ptomaine in artificial cultures of comma bacilli. (*Bacteria in Asiatic cholera. The Practitioner, 38, 1887.*) Speaking of the results of inoculation of cultures of comma bacilli obtained by Van Ermengem,

Klein says "the symptoms presented by these animals were those of acute chemical poisoning," and he endeavors to suggest a parallel between them and the cases of acute poisoning in the human subject (sausage poisoning, mackerel poisoning, poisoning by over-ripe fruit, tinned salmon, tinned sheep's tongue, etc.). Calling attention to the fact that Van E. obtained similar results with the culture fluid which had been passed through a Chamberland filter, Klein declares that "these observations are in harmony with those of Nicati, Klebs, and others, who have found that in artificial cultivations of the choleraic comma bacilli there is present a chemical poison, which in guinea-pigs produces acute poisoning similar to ptomaine poisoning," and a little later he also says: "We see, then, that there can be no question about the presence in certain artificial cultures of the choleraic comma bacilli (particularly in serum cultures 4 days old) of a chemical ferment capable of producing acute poisoning in animals, but the symptoms thus produced are comparable to ptomaine symptom." It is true, however, that Klein does not stop here, but seems to possess the untenable notion that there are essential differences neither between ptomaines of diverse origin nor between those of the choleraic comma bacilli and of "other septic organisms." Klein thus not only admits that choleraic comma bacilli are capable of forming a chemical poison, but he recognizes another very important matter, although its suggestiveness seems to have quite escaped him as well as many other acute observers while estimating the value of the negative results of their own inoculation experiments, viz, "That only certain cultivations of the comma bacilli contain this poison in a concentrated form, while others contain little or none, is, as shown in the experiments by Van Ermengem and others above mentioned, quite in harmony with Brieger's observations, who could obtain some of his ptomaines only from certain substances, not from others.

E. Klein, in a note at the end of his "The Bacteria in Asiatic Cholera," Practitioner, 38, 1887, thus speaks of the work of the English Commission led by Prof. C. Roy:

"A commission consisting of Prof. C. Roy, Dr. Graham Brown, and Dr. Sherrington, of Cambridge, was sent out to Spain in 1885, to decide between the contradictory statements as to the facts concerning the comma bacilli of Koch. These gentlemen have come to the same conclusion as myself, both as regards the distribution of Koch's comma bacilli in the intestinal contests and in the intestinal mucous membrane of cases of Asiatic cholera. They in their report (printed in the proceedings of the Royal Society, No. 247, p. 173) state that they are unable to accept the comma bacillus of Koch as casually connected with cholera Asiatica. They look upon the comma bacilli as probably connected with the premonitory diarrhœa; but these gentlemen furnish no proof whatever for their assumption. Messrs. Roy, Brown, and Sherrington describe in the mucous membrane of cholera intestines preserved for some months hyphæ or mycelial threads which they were told by Messrs. Vine and Gardiner were the hyphæ of chitridiaceæ, and they are not disinclined to look upon these as causally connected with cholera Asiatica. I have good reason for saying (see Nature for Dec. 23, 1886, and Brit. Med. Jour. of Dec. 25, 1886), that what these gentlemen figured and described (*loc. cit.*) are the hyphæ of common mould which have grown into the tissues during the process of preserving the material.

"It is fair to state that Mr. Gardiner has subsequently (Nature, Jan. 20, 1888) altered his view, inasmuch as he considered the organism shown to him in Professor Roy's specimens, *i. e.* moniliform threads with terminal nodular swellings, to resemble an involuted form of a bacterium. Still later (Nature, Feb. 3, 1887) he implied that to harmonize what he saw in Professor Roy's specimen with what has been figured by Roy, Brown, and Sherrington in their report (Proc. Roy. Soc., 247, p. 137) *i. e.* distinctly branched mycelial threads, both might belong to a form similar to *cladothrix dichotoma*. I have not the least doubt from actual observation, that the branched mycelial threads figured in the report of Messrs. Roy, Brown, and Sherrington are threads of common mould."

Nicati and Rietsch (Arch. de physiologie Norm. et Patholog., XVII, 3rd s. t. VI, 1885) report results of their careful investigation upon the relations of Koch's comma bacillus and Asiatic cholera, as well as the morphological and biological characters of these bacilli as



observed at Marseilles. The authors found the comma bacilli almost always, if not in the stools at least in the bodies of the cholera patients. They also found comma bacilli in the vomit of three out of eight cases. The numbers of the bacilli decreased as the duration of the disease lengthened. In very acute cases, at first the number is very great, but after four or five days it quickly decreases.

Control observations upon intestines of three suicides and upon the stools of twelve individuals affected with diarrhœa, always gave negative results. These authors confirmed the investigations of the French Cholera Commission in Egypt concerning the desquamation of the intestinal epithelium; according to their researches, the location of this alteration coincides with the location and development of the bacilli in the intestinal canal. In the rapid cases the bacillus was found throughout the whole intestinal canal below the duodenum; and in the less rapid cases, only in the ileum, particularly in the neighborhood of the cæcal valve. The authors found the comma bacillus once in the ductus choledochus, and in the gall-bladder twice.

According to them also, the bacilli penetrated the epithelium and extended into the connective tissues of the intestinal canal. They also confirmed the statement of Koch concerning the morphological and biological characters of the cholera bacillus. They placed special stress upon the characteristic odor which develops in the test tubes of cholera bacillus cultures, and ascribed it to the production of the alkaloid described by Villiers. They also mention that they discovered the curved bacilli in the intestines of a healthy man which morphologically might be mistaken for Koch's comma bacillus, although it possesses a plumper form and shorter curve in the formation of spirilli, but it is easy to distinguish by the appearance of its colonies in plate cultures. They regard this "false comma bacillus" as identical with the curved bacillus which Héricourt found in the ground water of Lille, as also with the Finkler and Prior bacillus.

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*RESEARCHES ON CHOLERA, THE COMMA BACILLUS IN THE ORGANISM, ITS CULTURE, ITS FERMENTATION PRODUCTS, AND THEIR ACTION UPON ANIMALS.*

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The pages which follow are the first part of a very extended work. A second part (Inoculation Experiments) is addressed at the same time to the Monthly Medical Review. A third part (Vitality of the Comma Bacillus) is in course of publication in the Review of Hygiene and Sanitary Police.

Our first business has been to investigate the comma bacillus that Dr. Koch had the kindness to demonstrate for us, and in our turn to make pure cultures from them and study the products of fermentation which arise in the cultures. It is the result of these first researches that we publish here.

I.—THE COMMA BACILLUS IN DEJECTIONS AND IN THE BODY OF CHOLERA PATIENTS.

(a) *Method of Research.*

It is indispensable to have water immersion or better still homogeneous immersion objectives; there is also great advantage in using proper illuminating apparatus.

Plate cultures are made according to the known methods. As to coloring, we have almost always used methyl violet; the coloring fluid was prepared by adding to 100 cubic centimeters of water saturated with aniline, 10 cubic centimeters of an alcoholic solution of methyl violet (Fuchsin of Bale) or else by directly dissolving 1 to 2 grammes of this last (a little more does no harm) in 100 cubic centimeters of the same water; the solution is then to be filtered.

The coloring is a question of but a few moments; if the solution is very cold, it is best to warm slightly the cover glass charged with the coloring fluid or to wait longer.

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\* Archives de physiologie normale et pathologique, 1885.

Experience has convinced us that a more intense coloring is obtained by the employment of mordants such as corrosive sublimate of 1-1,000, and particularly osmic acid of 1-100. These solutions are dropped on the cover-glass which is then washed before the coloring fluid is applied. One may also allow the entire flake to remain for a moment.

The preparations to be kept are well dried in the air, and mounted in fluid Canada balsam. To avoid discoloration, the preparation must not be dehydrated by alcohol or preserved in glycerine, nor must there be added balsam dissolved in chloroform or essence of *girofles*. The cover-glass preparations show only the morphological characters of the comma bacillus. Its examination in the living state can be made by a suspended drop or between cover-glasses. After observing its movements, one may add a drop of the coloring fluid in order to have the bacillus colored and floating in the liquid. In this way, the spirilli are not destroyed, which happens frequently with cover-glass preparations. By this process we have been able frequently to establish their presence when ordinarily the dry preparations do not show them (intestinal mucus).

The spirilli are however more numerous and longer in liquid cultures.

The isolated living commas are animated with rapid movements. At times they traverse rapidly the field of the microscope, then rotate whilst remaining fixed in their place. The spirilli advance by a gimlet movement when they are not long; in the latter case they appear inconvenienced by their length and hardly move at all or move slowly. The isolated bacilli and the short spirilli accumulate on the border of the drop, where they remain immovable.

The morphological characters alone can permit an almost certain diagnosis when the commas are numerous in the preparation. If they are, on the contrary, associated with other bacteria, the diagnosis may be doubtful. One can then use to advantage the *process of multiplication* indicated by Dr. Koch, and which consists in exposing the material in a moist chamber at a temperature of 20° to 30° and even 40° C.

When one has to do with a piece of intestine, it is sufficient to open the gut and expose it to the air in a moist chamber. When it is dejecta or usual intestinal matter, it is placed on linen resting upon some cotton at the bottom of a concave vessel, and the whole is then covered with a bell-glass. The greater part of the fluid runs off into the glass and there remains on the linen a semi-liquid mass. Ordinarily there is thus obtained at the end of twenty-four to forty-eight hours extremely rich material, often even almost pure cultures, and the preparations made from this material are very perfect.

One can arrive at similar results with the small intestine of the calf, sheep, or guinea-pig. That of the dog does not always give such good results. A piece of intestine as fresh as possible is taken, preference being given to the upper part, less rich in bacteria. It is opened lengthwise and washed with sterilized water. Along the inner surface is then drawn a piece of platinum, first heated and afterwards dipped in the suspected matter; the piece of intestine is then placed in a moist chamber, such as the preceding. We have in this manner obtained very beautiful cultures, particularly with the intestines of calves and sheep.

We ought to say, however, that sometimes when in the original material there were few commas, and, on the contrary, many bacteria of different kinds, we have not succeeded by this means in obtaining cultures rich in commas.

(b).—Results.

*Dejecta*.—For the examination of the stools, it is necessary, as far as possible, to use the rice-like flakes that they may contain.

We have examined microscopic preparations (without the test of culture) from stools of a large number of cholera patients: those stools which had characteristic aspects (but little colored and rice-like) have ordinarily given undoubted preparations.

In 31 patients we were able to examine the successive stools from the commencement or nearly the commencement of the disease, and we have in all these cases (but not in all the stools) found the comma bacilli. This fact confirms what Dr. Koch says regarding the constant presence of the comma bacillus at the commencement of cholera.



We will speak later, in connection with the general result of the autopsies, of the disappearance of the bacilli.

In the vomited matter the presence of the comma bacilli is much less regular, is exceptional even, and the individual bacilli are fewer. One can not have recourse to the moist chamber, for the multiplication does not take place in acids. The comma bacilli not being able to develop in the stomach, it must be admitted that they are derived from the intestines by the effort of vomiting. Out of eight specimens of vomit, all with acid reaction, we found in three cases the comma bacilli rather rare.

*Surface and contents of the intestines.*—The epithelial layer of the intestines can be scraped and examined by the ordinary methods; but for the examination of the deeper layers, it is necessary to harden the piece and make thin sections of it which should be colored blue by methylene.

We think we can affirm that the initial lesion is the swelling of the epithelial layer.

In the cases rapidly fatal, it is indeed found that the mucous membrane is covered entirely, not with its ordinary resisting and glistening epithelium, but with a thick, soft layer of a white color, a thick pasty pulp; it is in vain at this time to search for the least injection. The thickening of the epithelial coating is considerable throughout the small intestine below the duodenum, diminishing in the large intestine. The *psorenterie*, that is to say, the swelling of the closed follicles and Peyer's patches may depend upon simple swelling of the epithelial layer; it is sometimes wanting in the very rapid cases. We conclude from this that it is a subsequent lesion.

Later comes the desquamation of the epithelium which discloses the vascular injection around the Peyer's patches and closed follicles, as well as the extensive vascular injection of the ileo-cæcal valve. At these points the epithelial swelling has disappeared, or has been considerably lessened by the process of desquamation. Still later the injection extends upward and downward from the valve.

In the cases of delayed death are found subepithelial *ecchymoses*, scattered along the entire length of the intestinal tube.

In examining the epithelial layer obtained by scraping we have discovered the following facts:

(1) The microbe is not found in the stomach or in that portion of the duodenum near the *pylorus*.

(2) In rapid cases, it was found all along the rest of the intestine. The epithelial coating mentioned above is composed of epithelial cells and comma bacilli, at first in a relatively small number. If the mucous membrane is spread out in a moist chamber the comma bacilli multiply and the epithelial cells disappear; it is not rare to find at the end of forty-eight hours, instead of the mucous membrane, only a pulp almost exclusively composed of comma bacilli.

(3) Whilst preparations equally rich in the bacilli have been obtained, both from the duodenum and the large intestine, in rapid cases, this is no longer the same when the malady has lasted several days. The favorable places, then, are those where the epithelial coating has remained the most characteristic. Beautiful spots are usually found at a certain distance above the *ileocæcal* valve.

*Biliary passages.*—We have several times made bacteriological examinations of the biliary passages. Three times the comma bacilli were sought for only in the ductus choledocus (lower portion) and found twice; this was in cases of very rapid death. We sought them in the gall-bladder in five autopsies, two of which gave positive results. In one of these death had ensued the fifth day after typhoid symptoms; in the other the tenth day, also after typhoid symptoms. In the three cases giving negative results two were cases of rapid death; in the third, death had taken place after six days of illness.

*Tissues.*—We have examined sections of the wall of the intestine and demonstrated the presence of comma bacilla beneath the epithelium, and even in the adjoining connective tissues.

We also at three different times placed in the moist chamber for 24 hours pieces of liver and examined their superficial layers removed by scraping; the comma bacilli were not found therein.

We reserve the publication of our observations on the blood.

*Autopsies, general results.*—The bacteriological details of the autopsies have been published in the following table. (A table which is not reproduced here accompanies the work.) The three first columns indicate the sex and the age of the patients, the length of the sickness, and when death has taken place. In the three following the sign of + indicates that the very characteristic preparations contained numerous comma bacilli; the sign +\* that the characteristic preparations contained comma bacilli, still but less numerous; the sign +\*\* that the comma bacilli were rare; the sign — that we found none in the preparation. Several following signs indicate the results of preparations made from the intestine consecutively from above, downward, and at nearly regular intervals.

Of 31 autopsies the comma bacilli were found in 25 cases. The negative result of the six others is due perhaps to the relatively small number of preparations, and does not prove the absence of comma bacilli; even much more numerous preparations would not be absolute proof in this sense.

Here are the important facts of the six cases with negative results. In one autopsy (3) we were not able to learn the duration of the disease; in the five others, death ensued after 5, 7, 10, 15, and 19 days (autopsies 21, 27, 23, 5, and 15). Four times death had occurred in the period of reaction (3, 15, 23, 27), once in that of algidity, but after reaction (5); in the last case (21), the symptoms which preceded death were not noted.

We did not count No. 6 among the autopsies with negative results, although immediate examination gave no result. But the preparations were not numerous, and the stools examined during the sickness had given positive results; in all cases the comma bacilli were more or less rare in the autopsies (6th day, algidity).

In the cases of rapid death the comma bacilli were very abundant; towards the 3d or 4th day there seemed to be a tendency for them to disappear or at least to diminish; nevertheless, autopsy 17, where the intestine still gave a pure culture in a moist chamber (11th day, reaction), shows that one should not generalize from observations obtained in a limited number of cases.

The table does not indicate the evident relations between the disappearance of the comma bacilli and the entrance into the stage of reaction. One may say that the comma bacillus always accompanies the algid state, but does not always disappear with it.\*

As counter-proof or control of the examination of the intestines and the stools of cholera patients, we have made the three following autopsies: At various heights the intestine has been directly examined and put in a moist chamber. We have never found comma bacilli in cases non choleraeic. It was the same in the examination of diarrhoeaic stools of twelve different cases.

It is known that Koch and his students have reached also only negative results in analogous conditions.

We will discuss later on the opposite results obtained by Dr. Héricourt and Drs. Finkler and Prior.

Here we conclude by affirming the close relation which exists between the presence of the comma bacillus and the cholera.

## II.—CULTURES.

It is known that in order to demonstrate the pathogenic qualities of micro-organisms, Mr. Pasteur was led to entertain the idea of sowing in a nutritive but sterile liquid a very minute amount of infectious matter. The chemical poisons existing in this last found themselves thus

\* We will have to return elsewhere to the results of the autopsies in considering the vitality of the comma bacilli in the stools and in the intestines.



considerably diluted and attenuated, for they could not reproduce themselves. But the living organisms which were thus planted, on the contrary, multiplied rapidly if the media were favorable, and soon it became impossible to abstract a drop of liquid which did not contain micro-organisms. If this drop be introduced in a second liquid similar to the first, the original chemical poison will find itself already infinitely attenuated, whilst the living beings multiply anew. If it be these which produce the toxic effect, the second liquid will soon be as virulent as the infectious matter which served for point of departure; if the contrary be the case, it will be almost inoffensive. This would be still more true of the 3d, 4th culture, etc.

By this process one completely separates the micro-organisms and their products of secretion from all which accompanies them in the contagious matter, but one succeeds less certainly in isolating the micro-organisms one from the other. Yet this result is rapidly attained on replacing the liquid with a solid medium according to the Koch method.

If in the neutralized bouillon one dissolves warm gelatine, there is obtained a liquid which solidifies at 20° C. If to this liquid, partly cooled but not yet solid, one adds a small portion of contagious matter containing only a limited number of living beings, and shakes the whole, the bacteria will be scattered throughout the whole mass. Let this then be solidified by cooling, and the bacteria will be isolated one from the other. They multiply soon in this nutritive medium, and in the place of each bacteria there is soon found a little colony, an accumulation of microbes. Each of these colonies will remain isolated, the medium being solid; in a liquid they would be mixed. Each colony will be composed of only a single species of bacilli, microbes, etc.; each will have its special, specific characters, which, added to the morphological properties of the microbe composing the colony, will permit a surer and more rapid distinction of the different species. Finally, by taking a fraction of one of these colonies and sowing it anew in a new medium, one finds this time only a single species of living organisms.

This modification, introduced by Mr. Koch, offers, therefore, two essential advantages: It permits the rapid and sure attainment of pure cultures, and furnishes new distinctive characters, which are very important in a class of beings differing so little morphologically.

To prepare nutritive gelatine we proceed as follows: \* Take a piece of muscular flesh of beef, calf, sheep, or hog, without fat, tendons, or bones. Cut it fine and add cold water in a flask so as to form a pulpy mass. After about two hours it is strained and water is added anew to form a very fluid juice that is strained again two hours afterwards. The residue is boiled two hours in water, and is pressed and the three strainings thus obtained are mixed together with the fluid expressed from the boiled residue. This fluid is brought to the boiling point and filtered through paper while warm.

From 1 kilogramme of lean meat there should be thus obtained 1,500 to 2,000 cubic centimeters of bouillon. There is now added 10 grammes of chloride of sodium, 10 grammes of dry peptone, and 100 grammes of very white gelatine per liter (at Marseilles we reduced the gelatine to 60 or 70 grammes during the winter). The flask containing this mixture is placed in a water bath at a gentle heat until the gelatine dissolves; the fluid is then neutralized by a mixture of equal parts of bicarbonate of crystallized potash and bisodic phosphate, both dissolved in the least water possible and allowed to partly cool; add now to each liter and a half or two liters a white of an egg beaten up in a little water; heat in the bath in such a manner as to coagulate perfectly the albumen and to obtain a very clear liquid; the latter should be strained through felt or flannel in a water-bath funnel at 100°; collect the liquid in perfectly sterile decanters.

Besides, a sufficient number of sterilized test tubes of ordinary size are prepared. They are furnished with firm cotton stoppers 2 centimeters in length. They are placed in a dry heat sterilizer (we used the Wisneg), and for 1½ to 2 hours kept at a temperature of 160° to 170° C. There are sterilized in the same way a few flasks of about 1 liter for the reception of the filtered gelatine. The gelatine bouillon is then transferred, still warm and liquid, from the flasks directly into the tubes, best done by the aid of a pipette. These tubes are only filled one-

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\*The formula given by Dr. Koch is: Bouillon, 100 cubic centimeters; solid pepton, 1 gramme; chloride of sodium, 50 centigrammes; gelatine, 5 to 10 grammes. Neutralize with bicarbonate of soda or trisodic phosphate.

third (10 cubic centimeters of gelatine are sufficient for each). The tubes are immediately restopped and heated for an hour in a bath of boiling water. This last operation is then repeated once or twice at 24 hours' interval. It is necessary to avoid heating the nutritive gelatine too often and too long, for then it does not solidify so well afterwards.

The tubes thus prepared should be kept 8 to 15 days at a temperature of about 20° C. Those only are used which show no development of micro-organisms.

In the place of the gelatine, agar-agar may be used in order to solidify the peptonized bouillon, but this medium reliques only at a much higher temperature than the gelatine.

There are prepared the same way tubes containing only bouillon and others containing bouillon with 1 per cent. of peptone. In either case it is necessary of course to neutralize and sterilize the liquid. One can also use the serum of coagulated blood, but its preparation is more difficult, and it does not offer such great advantages. To make a culture, a stool or piece of intestine from a cholera case, or, better still, either may be used after remaining 24 to 48 hours in a moist chamber within an incubator.

With a sterilized platinum needle take up a little of the substance and put it in 10 to 20<sup>cm</sup> of sterilized water. With a sterilized pipette take a drop of this water up, which serves as seed. One can inoculate directly with the platinum wire the choleraic substance, having care to take only a small quantity. At the same time, a tube of nutritive gelatine has been melted by a gentle heat and allowed to cool to 30° C. The cotton stopper is rapidly withdrawn, the surface of the gelatine touched with the platinum wire charged with the material, or a drop of water may be added, and the tube immediately restopped. The tube is then at once shaken several moments so as to diffuse the bacteria as much as possible and in a uniform manner throughout the mass, then the gelatine is poured either into glass cups or on to glass plates.

*Cultures in shallow dishes or on glass plates.*—The first are cylinder glasses of 3 to 4 centimeters in diameter flat bottomed and shallow sides (about 1 or 2 centimeters deep, in order to permit examinations by magnifying glasses and microscopes). Other glasses of the same form, but a little larger and still a little shallower, serve as covers. These two cups close one on the other like the parts of a pill-box. These double vases are sterilized in the dry sterilizer or by singeing. The cover is raised only to pour in the gelatine and is immediately replaced. For plates, one can take the ordinary objective slide used for microscopic preparations or larger plates. They should be sterilized, and then the inoculated gelatine is poured on the surface and spread out with a glass rod which has been sterilized. The layer of gelatine should not be of more than a few millimeters in thickness. Solidification can be hastened in summer by artificial cooling. The cups are next placed directly in the incubator at 18° to 20° C. The plates are immediately introduced into an ordinary moist chamber for microscopic objects.

At the end of 24 hours minute colonies are visible to the naked eye. The transparency of the gelatine is seen to be clouded by little points more or less close together, according to the quantity of the bacteria sown. They are always in the first culture very diverse colonies. Those of the comma bacilli have been already described by Dr. Koch. Nevertheless, it will not be superfluous here to refer to their character by adding some details in order to make them more easily recognized.\*

The youngest colonies of comma bacilli are presented as very small colorless droplets, highly refractive and transparent. They are at first homogenous, but they quickly lose this character. Examined with a hand lens, or with a microscope of low power, they appear divided in irregular fragments by fine striæ of a darker shade. The small point assumes a fragmented appearance, resembling, as Koch has said, little fragments of glass. By reflected light these colonies are very pale, light, and slightly glistening. Their contours are not ordinarily regular, but present little juttings and a fragmentary appearance. The colony, growing and becoming thicker, remains still very pale, but nevertheless shows a grayish tint, feebly shaded with yellow. The resemblance to pieces of glass becomes greater, the contours are frequently hacked. The appearance of the entire colony recalls that which just now we call the nucleus in the more advanced colonies.

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\* See the authors' note in the report of the French Academy of Science, January 26, 1885.



If the sowing has been too abundant, if the colonies of diverse bacteria are too close to each other, this stage can not be passed, and the gelatine liquefies before the colonies of comma bacilli have taken more definite characters. They can therefore pass unperceived, all the more since the other colonies are ordinarily more colored, less transparent, and more striking to the eye. Research will be facilitated by examining by reflected light with a magnifying glass, or in using an oblique light, and with a little practice one will avoid the difficulty to which we thought it best to call the attention of beginners.

A little older colony taken from the surface of gelatine possesses all the distinctive characters. At the center is seen a nucleus recalling the younger colony just described. It is darker than the exterior zone, of a feeble gray color, with just a little yellow. It does not present a homogeneous appearance, but is coarsely granulated, as if cracked. Still more than the preceding colony, it resembles a mass of fragments of glass. Its borders are hacked more deeply. It is surrounded by a zone the appearance of which is somewhat clearer, and which is strewn, nevertheless, with little glassy fragments, but they are very sparsely scattered and leave almost free the somewhat irregular surrounding zone. This peripheral zone is transparent. Its exterior border, which forms the limit of the whole colony, shows a little darker and more finely indented. In the larger colonies it is still easy to distinguish these transparent zones.

If the focus of the microscope is gradually moved up and down one sees that the nucleus is sunk deeper in the gelatine than is the border of the surrounding zone. These appearances are also very easily seen in examining with a lens or by the naked eye the colonies on a glass plate or in a dish. They give the effect of a cup-shaped ulcer, sunk into the surface of the gelatine. By profile examination it is still easier seen that to each colony there corresponds an excavation the nucleus of which occupies the bottom. One would almost think, as Dr. Koch says, that the comma bacilli determine the evaporation of the water.

At any rate, the comma bacilli render the gelatine fluid. This liquefaction of the gelatine extends only to a certain distance (about 1 millimeter) beyond the edge of the nucleus, which is visible to the naked eye or a magnifying glass.

The development continuing, the colonies finally touch each other and then become united. The gelatine is liquified little by little throughout the mass, and there soon remains nothing but the nuclei or their *debris* floating in the fluid.

It is not necessary to wait long in order to use this first culture in making new ones. The first inoculation made with the choleraic matter always gives rise to divers colonies. If only a little matter is inoculated they may be far enough apart to pick up one without touching the others with a platinum wire, and in that case one can then directly inoculate the solid gelatine contained in the tube. But often it will be necessary to first make a second plate culture by taking from one of the first colonies as little matter as possible with the platinum wire. In this second plate culture it will almost always be easy to find a colony well isolated, a part of which can then be transported to a tube.

*Tube cultures.*—As in this operation one is not absolutely safe from contamination by air whatever precautions are taken, it is best to inoculate several tubes at a time (6 to 12). The gelatine is not to be dissolved. The tube being unstopped, the medium is punctured by the contaminated wire. The wire is withdrawn and the tube immediately restopped. It is important that this be done as rapidly as possible; all unnecessary movements should be avoided in the laboratory. But we will return again to this subject.

If one has been content with touching the surface of the gelatine, there is soon obtained a colony similar to that just described. It is still better seen now that it corresponds to an excavation, the nucleus of which occupies the bottom. The colony growing larger, the depth of the excavation increases, and one has then, as Dr. Koch has said, the appearance of an air bubble suspended above the colony. This air bubble is not peculiar to the comma bacilli; it is encountered in still other bacteria.

If the needle is plunged deeply in the gelatine, there is seen at the end of 24 to 48 hours all along the course that it traversed a slight opalescence which is transformed later into an

irregular column composed of opaque lumps, of a dirty yellowish white. The upper part of this column is funnel shaped, the bottom of the funnel is occupied by liquefied gelatine, opalescent or lumpy. This liquid is surmounted by an air bubble. The gelatine liquefies next around the column for the entire depth and there is then seen a central white and lumpy axis placed in the middle of a cylinder much more hyaline (liquefied gelatine) and slightly opalescent. The liquefaction spreads towards the surface quickly, where it soon reaches the edges of the tube, and then evidently the appearance of the air bubble no longer remains.

Of course the composition of the colonies and the purity of the cultures must be controlled from time to time by microscopic examination.

We have also made a few cultures on boiled potatoes. The comma bacilli form upon them a thin layer, gray at first, then becoming whitish. It remains superficial and does not penetrate into the depth of the potato.

The rapidity of multiplication of the comma bacilli is very different with the temperatures and the media employed. It is in general greater in liquids where numerous spiral forms are observed. We have not made attempts to find the best temperature, which Dr. Koch places between 30° and 40° C. But at a temperature of from 18° to 20° the development is still very rapid. It is at this temperature that we have ordinarily kept the nutritive gelatine. Below 18° C. the development becomes much slower. In the tubes that we placed at a temperature between 8° and 11° C., it did not quite cease. But at the end of 15 days the colonies were hardly appreciable. It is therefore necessary to place the cultures in the incubator during part of the year.

In the gelatine tubes the bacilli liquefy little by little the whole mass in its upper part. There is then seen on the still solid portion of the gelatine an opaque thick white layer, consisting of living bacilli and their débris; the fluid gelatine above this layer contains a great deal less bacilli. The latter are more abundant near the surface of the liquid. The cultures now proceed downward liquefying the gelatine little by little. But this process becomes more and more slow. The accumulation in the liquid of the products of excretion is without doubt an important factor in the arrest of growth. The rarity of oxygen acts probably in the same way. In a culture 15 days old we found in the air of the tube 3 per cent. of carbonic acid. This gas, heavier than the air, accumulates at the surface of the liquid in an atmosphere besides calm and communicating with the exterior only through a thick cotton stopper. This layer of carbonic acid gas contributes, with the layer of liquid gelatine, in rendering the access of oxygen difficult in the location where the bacilli accumulate. At the end of a few weeks (6 to 8 ordinarily) there are no longer found living comma bacilli in the tubes. Inoculations from them prove sterile, and the preparations show débris of bacilli and bacilli badly stained, sometimes spirilli thicker than normal. At this moment all the gelatine has ordinarily become liquefied. Nevertheless, we have also had a few such tubes showing at the bottom solid and intact gelatine.

Nutrient fluid media are more favorable than solids for the rapid development of the comma bacilli. But it is best at the beginning only to make inoculations from gelatine tubes in which the perfect purity of the cultures has already been determined by the character of the colonies in plate cultures and by microscopic examination. The test tubes with bouillon are kept not less than 48 hours at a temperature of 22° to 25° C. Bouillon with peptone added is a still better medium. At the end of 3 to 5 days there is seen at the surface of the liquid a little pellicle of a dirty white which breaks easily and the fragments fall to the bottom. When the tube rests motionless this pellicle becomes thicker and more consistent. The bacilli do not seem to remain alive a long time in these colonies, the preparations of which show the comma bacilli badly colored, and the fragments of pellicles inoculated into nutritive gelatine no longer give origin to new colonies.

It is seen by the preceding that the cholera microbe lives only a short time in the culture tubes. To preserve these cultures living it is therefore necessary to make new inoculations at intervals, varying with the temperature. These inoculations must be made with great caution to prevent the contamination of the pure cultures. We have succeeded best in



preserving the purity of the cultures through successive inoculations by the following method: We attribute this difference to the fact that it permits only sowing of small quantities of the virulent matter. A strip of platinum wire considerable longer than the culture tube is taken. The tube which is to serve for new inoculations is held in the left hand and slightly inclined. The thumb and finger grasps the upper extremity of the cotton stopper. With the right hand the strip of platinum is strongly heated and introduced warm in the tube, the stopper being raised for the purpose and allowed to rest on the upper lip of the tube so as to allow a free space between the lower lip and the cotton. The strip is allowed to penetrate as far as the surface of the liquid, and the bottle immediately restopped. It is necessary to operate as rapidly as possible to avoid contamination by the air. For the same reason the hands are washed in bichlorate of mercury before commencing. In a few seconds the wire is cold. By shaking or inclining the tube the wire touches the culture liquid from which the inoculation is to be made and is then withdrawn through the cotton stopper, which leaves on the platinum only a little matter. This wire is now inserted rapidly and repeatedly into a gelatine tube, which is inverted when the stopper is drawn, or else into a tube of bouillon that is slanted as much as is possible.

Slowly developed cultures of comma bacilli possess constantly a free alkaline reaction. They tinge red paper very distinctly blue. But this paper exposed to the air resumes in a quarter or half an hour its original color, or else preserves only a very pale bluish tint if the inoculated nutritive liquid was already lightly alkalined. This shows that there forms in the cultures a substance of alkaline reaction which exposed to the air volatilizes after a little while (or alters while ceasing to be alkaline). The same reaction is also found in the old cultures which have become sterile; never have our pure cultures revealed the presence of free acid. They present another particularity: that is, a peculiar odor, faint, and a little stale, but neither putrid nor even disagreeable; it could rather be called an ethereal odor. We have met with it in the pure gelatine and peptone bouillons; it appeared less pronounced with simple bouillon. The rice-water stools of cholera patients and the intestinal contents in the algid period do not possess a putrid odor. Placed in a moist chamber, at a temperature of 25° to 30° C., and converted thus into almost pure cultures, they also manifest an odor almost identical to that of the cultures. We have remarked it several times when coming from out of doors we have opened the incubator which contained the pieces of intestine. Let us recall in connection with this subject the fact that Dr. Villiers extracted from the choleraic intestines an alkaloid of a fresh hawthorne odor, which could very easily be the same as that of the cultures.

*Morphological characters of the comma bacilli.*—It is not enough, at least in many cases, to establish the characters of the colonies; it is necessary to join thereto those of the bacillus itself. Preparations from the colonies or from the fluid cultures are made as we have described for the intestine. The bacilli present the form of slightly curved rods (comma-shaped, according to Koch). This curve is variable according to circumstances. There are some only slightly curved, and others forming a semicircle. The length is also very variable. In cultures there are frequently some very short, not more than .5 to .7  $\mu$ . One is almost tempted to take them for cocci, if their curving was not always well marked. The average length is about 1.5  $\mu$ ; in preparations from stools and intestinal contents it is rarely less than 1  $\mu$ . But it is difficult to indicate a more definite limit. They remain closely aggregated, particularly in the liquid cultures, so that it is impossible to distinguish the points of separation, either in the living state or in colored preparations. Most frequently they then dispose themselves in spirals. But individuals, usually two, may be united to form an arc or a horseshoe. There are frequently found bacilli approaching or reaching 2  $\mu$  in length or even surpassing it.

The thickness is more regular, but it seems to us to be a little variable also. Bacilli preserved for several weeks in salt water appeared to us usually more thin. In the intestinal contents of cholera patients they are sometimes found thicker than ordinary.

In the intestines and in gelatine there are seen only rare and very short spirilli. They always appear more numerous when examined in the living state; the spirilli appear therefore to disintegrate by the mere act of making the preparation. With bouillon, and particu-

larly peptone bouillon, there are obtained spirilli longer and more numerous. In this latter the preparations sometimes contain veritable clusters. The clusters of the spirilli may be very close together, and the undulations are then abrupt. But the waves may also be so elongated as to give to the spirilli the appearance of almost a straight line. One obtains frequently very characteristic figures, due doubtless to disintegrating spirilli during the preparation. They are commas arranged in a line, very close together, but isolated nevertheless and separated by very short intervals. Most frequently they are then all concave, almost all in the same direction.

In short, the comma bacilli multiply by fission, and the newly-formed cells may remain attached in the form of spirilli. But this grouping together is but slightly resistant.

*False comma bacilli.*—The aspect of the colonies of the choleraic bacilli is very characteristic. We must, however, describe other colonies offering a certain resemblance to them.

We have already described in the intestinal matter of healthy men and divers animals a curved bacillus resembling the comma. In our plate cultures we have several times found colonies formed by the same bacillus, and we believe, therefore, that these germs may probably exist in the air. These colonies have a hyaline appearance and granular aspect, which distinguishes them from the majority of other bacterial colonies, and shows their relation to those of the true comma bacilli. Their color is however grayer and a shade darker; they are also more uniformly granulated, and the dentated external border is marked by numerous glistening striæ or rays, appearances which are never seen in the colonies of the true comma bacilli. Upon the surface these rays are isolated and very distinct; in the interior they become less distinct; finally, in the center is found a gray and finely granulated nucleus. Later there is seen to appear on the outside a zone of liquefaction with the outline of a festooned ribbon, the undulations of which correspond to those of the middle zone, which presents always at its external edge a very distinct radiating zone. But it never becomes hollowed out as in the colonies of cholera bacilli, and its appearance is always more uniform. At the same time, the nucleus ordinarily breaks up into irregular fragments. The colonies grow more rapidly upon the surface of the gelatine, which they liquefy quickly; they may attain a large diameter.

If with isolated bacilli confusion might be possible, it is no longer so with preparations which contain a great many, particularly with those made from the colonies. One easily sees then that the false commas are more voluminous, especially thicker than the cholera microbe, notably less curved, and frequently straight or almost so. We have not made cultures of them in bouillon; in the gelatine we did not observe any spirilli. One encounters frequently two united end to end and forming a longer and greater curve, but divided in the center. This bacillus does not develop on moist linen.

Dr. Héricourt has discovered in the waters of the Lower Deule at Lille a bacillus more curved than that the form of that of which we have just spoken. Dr. Héricourt had the kindness to send us some of that water. By placing several drops in gelatine we obtained numerous colonies identical with those that we have just described. From the number of these colonies and their presence in all the plates we think that the bacillus came from the water and was not floating in the air of the laboratory. It was certainly identical to our *false comma*. In the absence of the characteristics of the colonies, we could not make the same affirmation of the bacilli, more or less curved, in the preparations that Dr. Héricourt had the kindness to send us. But we incline strongly to that opinion. It is certain that these last are distinguished even morphologically (and this is not only our opinion) from the cholera bacilli. There could be no hesitation, we repeat it, except with certain isolated individuals. We did not find in the preparations of Dr. Héricourt forms as curved as those that he has described in the *Revue d'Hygiène*.

Does this false comma have any relations with the curved bacilli contained in the cultures of Drs. Finkler and Prior? There is certainly reason for thinking so, according to the description that Dr. Koch has given of this bacillus and its colonies. We would then have to do with a bacterium widely extended and having nothing in common with either Asiatic cholera or the *cholera nostras*.



We will call attention also to the colonies formed by a straight bacillus, which can not by any means be confounded with the comma bacillus. These colonies resemble some to those of the comma bacillus, particularly when located, for instance, in a thin layer of gelatine, they commence to dry. They then appear also to be composed of the three same zones, and the resemblance is great, particularly for the middle lacunary zone. But other characters, such as the darker nucleus and less granulation, the larger external zone with more regular contours, and the microscopic preparations of the bacilli, do not permit in any way of confusion.

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#### CHOLERA INOCULATION EXPERIMENTS.

By Drs. NICATI and RIETSCH.\*

A bacillus always accompanying cholera and existing as a cholera contagium has many chances of being the cholera microbe. Dr. Koch has not hesitated to affirm this, notwithstanding the want of success of his first attempt at inoculation of animals. The absence of this physiological proof was, according to him, devoid of all negative force so long as it is not proven that the animals are susceptible to the choleraic contagium. Now, no one has established the co-existence of an epizootic among animals having the characters of human cholera and accompanying the progress of a cholera epidemic.

Chicken cholera has evidently nothing in common with human cholera, although the authors thought so at first. It is to be met with, as is well known, unaccompanied by invasions of Asiatic cholera.

Hildebrandt has asserted that during the cholera epidemic that swept over Galicia and Hungary in 1831-1832 the domestic and wild animals, the fish, and plants were all diseased. But one could not consider this as an instance of a cholera epizootic. Moreover, there is found mention by this author only of sporadic cases developing in a chicken and a dog, in a tiger, a panther, and an eagle.

We have ourselves made the autopsy of a dog (Havana) dying after having eaten the vomit of a cholera patient. It was sent to us by Dr. Cousin. Was this undoubted cholera? The fact is the intestinal matter contained no comma bacilli. Dr. Foëx observed last summer at Marseilles still another incident of a similar kind concerning a dog, but of which no autopsy was made.

There is reason, we believe, for being cautious in the diagnosis of similar cases. Whatever one may think and whatever may be the result of later and more careful examination, it is not established that there has ever been a cholera epizootic coinciding with a cholera epidemic. That is what the commission of 1865 of Munich declares, as well as the author of a work on this subject (Wolfhügel). The absence of all mention in the treatises and annals of veterinary medicine points in the same direction.

We have not, however, allowed ourselves to be deterred by these facts, and have ourselves resorted to experimentation, persuaded that negative results, although numerous, are not conclusive and may be the result of physical or physiological difficulties which may be overcome.

We will review all the experiments that have been made both by our predecessors and by ourselves, pointing out at their proper place the hypotheses which have led us to our last attempts.

It is well known that experiments were made at the time of the appearance of cholera in Europe. We even find it indicated that French doctors have inoculated themselves. "It is with perfect safety, we read, that French doctors have been able to practice this inoculation on themselves, for it is not in the humors, circulating or secreted, that the virus lies. (Notices et documents sur le choléra, traduits par Peschier, Genève)." This without doubt refers to inoculation, as with vaccine. We cite this fact as a mere curiosity, hastening to pass on to the control experiments.

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\* *Rev. de Med.*, t. v.—June, 1885.

Our work is divided into two parts: The first includes the experiments made with blood, intestinal matter, and the bile of cholera patients; the second, experiments made with pure cultures of the bacilli of Koch.

DIVERS EXPERIMENTS MADE WITH MATTER TAKEN FROM CHOLERA SUBJECTS, SUCH AS BLOOD, INTESTINAL CONTENTS, BILE.

I.—EXPERIMENTS WITH BLOOD.

A.—*Injection of blood of a cholera patient, under the skin and into the peritoneal cavity.*

Namias (Dict. encycl. de Dechambre, art. choléra, p. 801) made this experiment in 1836 without results (injection under the skin).

Others after him have been more fortunate; here are our experiments:

Experiment I. There was injected under the skin of a dog 2.5 cubic centimeters of blood fresh from a person dying in the algid stage of cholera. No trouble results, the dog's health undisturbed.

Experiment II. There is injected under the skin of a dog's abdomen fresh blood from a cholera victim (dying in the algid stage in the sixth day of the disease) mixed with water. The animal for 1 day refused to eat—the only symptom of indisposition.

Experiment III. Same experiment with the same blood on a hog; same indisposition of 1 day.

Experiment IV. Same experiment on a guinea-pig with the blood of a cholera victim who died rapidly. Remained 2 days without eating, and got well without any other symptoms.

Experiment V. Injection into a dog of three Pravaz syringes of fresh blood from a person dying in the algid stage. Absolutely no morbid symptom.

Experiment VI: Injection into the peritoneal cavity of a dog of fresh blood of a cholera victim (algid). The animal vomited during the night after the operation. Got well without any other symptoms.

The stools of several of these animals were examined. There were found no choleraic comma bacilli.

*Conclusion.*—The injection of the blood of a cholera victim into the tissue under the skin and into the peritoneal cavity can produce a transient indisposition. It does not produce cholera.

B.—*Injection of cholera blood into the veins.*

Magendi first made this experiment in 1832; others have repeated it, particularly Lindsay, in 1836.

Our Marseilles confrère, Dr. Livon, performed this experiment twice. These were Dr. Livon's results:

Experiment I: In a first experiment we injected into the jugular vein of a rabbit, blood from a patient in the algid period. The next morning the animal was found dead. The autopsy revealed the following facts: In the *pericardium* there was extravasated blood. The heart was completely filled with a clot resembling currant jelly, the *venæ cavæ* and the *aorta* were filled with a clot presenting the same appearance, and there was no difference between the appearance of the venous and the arterial clots. The blood had an acid reaction.

Experiment II: In another case, we injected into the right jugular vein of a rabbit blood taken from the corpse of a cholera victim. The animal was found dead the next morning. The autopsy revealed the following facts: Yellowish fluid in the *pericardium*, a black clot in the right heart. The arteries contained blood. There was a very marked injection of the peritoneum and of the *mesentery*. The peritoneal fluid is viscid and stringy. The kidneys were injected and the lungs hyperæmic. The Peyer's patches are very salient; there exists a very marked desquamation of the epithelium of the intestine. The bladder contained almost no urine.



The following are our own experiments :

Experiment I : Injection of 3.5 cubic centimeters of blood from a victim of *foudroyant* cholera, taken after death in a sterilized flask, and injected two hours later. The dog is immediately very prostrated and shivers. The next day and the day following he is in the same state. He is found dead at the end of three days. Autopsy : Blood of the heart, black ; only a few clots of a dark color, no fibrous clots. Stomach and upper portion of the small intestine contain blood in abundance.

Experiment II : A young pig of about 40 or 50 kilos in weight. Injection into the abdominal vein of 7 cubic centimeters of blood from a cholera victim, dying after several hours' sickness. The animal is soon very prostrated. The feet, nose, and ears are lifeless and cold to the touch. He is found entirely recovered the next day.

Experiment III : A little dog. Injection in the crural vein of a Pravaz syringe of cholera blood from a rapid case; appears at first prostrated, but recovers after a little more than 24 hours.

*Conclusion.*—The injection of cholera blood into the veins in a sufficiently large quantity produces cyanosis, algidity, and even death. Have we here to do with poisoning or a parasitic infection ; that is to say, real cholera transmissible to other animals ? We are inclined toward the first hypothesis ; the almost immediate appearance of symptoms and their prompt cessation, the very rapid death in the experiments of Livon, are certainly rather the effects of poisoning. A parasitic infection, the effect even being due to the secretion of a poison, would not act at once, but only after a certain lapse of time. In our first experiment, death took place only after three whole days.

## II.—EXPERIMENTS WITH THE INTESTINAL CONTENTS OF CHOLERA VICTIMS.

### *A.—Subcutaneous injection.*

This experiment has been repeated by several authors (Cuttman, 1862, Snellen and Miller, 1867, etc.). It produced death when the injection was very abundant, but never produced the symptoms or complaints of cholera.

Our experiments have been as follows :

Experiment I. A dog. Injection under the skin of the abdomen of 6 cubic centimeters of intestinal pulp from a cholera victim who died on arriving at the hospital. The animal is very prostrated the next day and the days following, and dies at the end of five days. No cholera symptoms ; no appearance of cholera at the autopsy. In the blood of the heart there was a large curved bacillus.

Experiment II. A dog. Subcutaneous injection of the intestinal contents of the same cholera victim of the same quantity filtered. A little malaise and prostration the next day; muscular trembling, ears cold to the touch. No bacteria in the blood. Recovered after the following day.

Experiment III. A dog. Subcutaneous injection of 150 grammes of intestinal contents of the same cholera victim, boiled and filtered. No symptoms whatever.

*Discussion.*—The subcutaneous injection of the intestinal contents of cholera victims does not produce cholera. The animal dying appears to have succumbed to septicæmia.

### *B.—Injection into the veins.*

Experiment : Injection of 3 cubic centimeters of fresh intestinal matter. The next day the animal is prostrated, warm; his blood abounds in bacteria of all sorts with very few commas. Dies the following day.

Death evidently resulted from septicæmia.

The similar experiments made previously, and in particular those of Charles Legros and L. Goujon have not elicited more favorable results.

*C.—Injection into the windpipe.*

The experiments made by Legros and Goujon provoked only doubtful symptoms. We have not repeated this experiment.

*D.—Injection into the digestive canal.*

**A. EXPERIMENTS ON THE DOG, HOG, CAT, AND RAT.**—(a) *Introduction into the stomach.*—Numerous investigators have experimented with the dejections of cholera patients on animals the greater part without result, as Guyon at Warsaw in 1831. A few have seen animals succumb, such as Legros and Goujon, in 1867, after ingestion of enormous quantities. Dewalque caused dejecta to be swallowed by two dogs; one of the two died with all the symptoms of cholera. Crocq, out of twelve dogs thus treated, saw three die, 1866. Quite recently Richards, an India medical officer, after fruitless attempts on dogs, tried several on hogs; they died with cramps after an interval of from 15 minutes to 2 hours and a half. The intestinal matter of the dead animal administered to another hog gave no results.

In all these experiments there lacks the proof of reinoculation. Death may be due to that very toxic ptomaine, the presence of which has been established in intestinal matter of cholera victims by Gabriel Pouchet, and by Villiers, or to some other poison of this kind. This is also the opinion of Dr. Koch, in regard to Richards' observation. This author remarks with reason that the fact of death ensuing after a very short time is itself in favor of poisoning.

A special place must be accorded to the experiments of Thiersch, at Munich, in 1845, in which there could be no question of poisoning, on account of the small quantity of matter injected. This author gave to mice little pieces of paper dipped in liquid intestinal contents and then dried and mixed with their food. The paper had been dipped sometimes in fresh liquid, sometimes liquid passed six hours before and kept at a temperature of 10° C. One hundred and four mice were submitted to this experiment. Those which swallowed the paper impregnated with fresh injections experienced no morbid symptoms. Of the 34 which had swallowed dejections of from three to nine days old, 30 became sick and died. It is not stated whether there were reinoculations with the dejections of the mice. Dr. Koch has repeated this experiment exactly; with him the mice remained in a state of perfect health.

Our experiments were as follows:

**Experiment I.** Four hogs swallow in a gluttonous manner a whole tub full of intestinal contents of a cholera victim who died in the algid stage. No morbid symptom manifested itself.

**Experiment II.** Two hogs eat a portion of the small intestine of a woman who died in the algid stage. No symptoms.

**Experiment III.** Two kittens ate a tart to which was added intestinal contents 8 days old (still rich in comma bacilli). There were no symptoms.

**Experiment IV.** Ingestion after a prolonged fast. A dog made, after a fast of 18 hours, a copious repast from bread and meat cut up and mixed in a vessel of choleraic matter which had been vomited 3 hours before and to which there had been added 10 drops of fecal matter rich in comma bacilli. The evening of the same day he vomited and trembled. The next day he recovered; the day after no symptoms whatever. The fourth day a diarrhœa which lasted only 1 day (the stools contained only very doubtful curved bacilli?).

Dr. Koch having shown and we having verified that the comma bacilli succumb rapidly in acid liquids, and particularly in the gastric juice, we rendered the fluids alkaline.

**Experiment V.** Three dogs received a tart, rendered alkaline by bi-carbonate of soda, and stirred, 17 hours before the repast, with a stick previously dipped into choleraic stools (rich in comma bacilli). One of them had a little diarrhœa the first day; did he have it before? Another was a little indisposed the fifth day; from coughing and barking he falls into a sort of apathy, trembling of the muscles, then convulsive movements of the neck and of the extremities. This state disappeared the next day. The third showed diarrhœa after the fifth day; he was killed the eighth; he presented no symptoms of cholera, and there were found no choleraic comma bacilli any more in him than in the rest.



Experiment VI. Three dogs fed with tarts rendered alkaline after a fast of 18 hours. The tart is stirred with a stick which had touched the surface of choleraic stools. There was no symptom whatever.

Experiment VII. Addition of croton oil. Two hogs eat with avidity the whole intestinal contents from a case of *foudroyant* cholera. The next day they eat a tart with intestinal matter, rich in comma bacilli, with the addition of 5 drops of croton oil. The third day 10 drops of croton oil were given to each, and there was a severe diarrhœa. No loss of appetite, no vomiting, no cramps, no cyanosis, etc.

Experiment VIII. Artificial diarrhœa before ingestion. A hog, which the day before had received 3 drops of croton oil, eats intestinal contents from the same corpse. The next day a new mixture of intestinal matter, rich in comma bacilli to which are added 3 drops of croton oil is given; the fourth day 20 drops of croton oil are administered in the morning and 20 drops in the evening; the fifth day the same; the sixth, 50 drops in the morning and 45 in the evening. The animal did not cease to eat with avidity, and did not appear discommoded by the diarrhœa which was severe, but ate a large quantity of the contents of the intestine of a cholera corpse (rapid case). No symptoms except the diarrhœa, which finally stopped of itself.

It was in this experiment and in the preceding that, finding constantly comma bacilli in the stools, we concluded by demonstration that they were false comma bacilli which did not multiply on damp linen, but which formed colonies, the means of diagnosis of which we have given elsewhere. It was on this occasion also that we often saw present in the stools of the hogs a comma bacillus smaller, thinner, and more curved than the choleraic comma. We did not pursue their culture, no more than that of a similar organism developing in the intestinal mucous membrane of a dog, previously washed and exposed in a moist chamber. The difference between these comma bacilli is great enough for a single glance into the microscope to prevent confusion.

*Conclusion.*—The introduction into the stomach of intestinal matter from cholera patients has not produced cholera even when we made the animal fast, rendered alkaline the matter introduced, and provoked artificial diarrhœa.

(b) *Introduction into the intestine.*—Experiment I. A dog from the parlor. The loop of the small intestine is laid bare. Injection into it of intestinal matter from a cholera victim, rich in comma bacilli. The dog gets well without any symptoms.

The same experiment is made on a second dog with diluted matters. Some vomiting in the evening; the next day a little diarrhœa (no comma bacilli) lasting only 1 day, and followed by recovery.

Experiment II. A dog. An intestinal fistula is made in a loop of the small intestine. Injection of cholera matter, rich in comma bacilli. There is injected at the same time air in abundance, with the thought to favor the growth of the bacteria. A little vomiting on the third day. No comma bacilli in the stools, neither the next day nor the day after. The third day, the dog being completely recovered, a new injection of fœcal matter, rich in commas, was made, followed after 2 hours by an abundant injection of water, to which was added 2 drops of croton oil. The animal ceases to eat for 3 days; a watery diarrhœa without comma bacilli. No cholera symptoms. The animal is killed the sixth day, but no traces of cholera are seen.

Experiment III. A rat. Injection into the duodenum of one-half Pravaz syringe of the intestinal contents of a cholera patient. A rapid recovery and no cholera symptoms.

The same experiment on a dog; vomiting the next day (no comma bacilli); a rapid recovery.

Experiment IV. Injection into the duodenum after ligature of the ductus choledochus. This experiment was inspired by the idea that the absence of bile in the cholera stools might favor the growth of the comma bacilli, an idea which was not verified by the result.

We were besides assured in advance that the ligature alone of the choledochus does not provoke the development of the comma bacilli, following a prevalent hypothesis which looks upon the comma bacilli fermentation as a consequence of the malady.

**Experiment:** A dog is operated upon by a ligature of the ductus choledochus (classic method). He received, besides, an injection of cholera matter. The dog died in 24 hours. The small intestine is found gorged with a pulpy mass of a rosy white aspect as far as the ileo-cæcal valve for a length of nearly 2 meters. This pulpy mass contained comma bacilli in abundance.

**Conclusion.**—Up to the present we had never obtained in our experiments a reproduction of the comma bacilli. In the last experiment injection preceded by ligature of the ductus choledochus, this result is obtained for the first time. We will return to this experiment in the second part, where more numerous facts will be at our disposition.

(c) *Introduction into the Choledochus*—Experiment V. Injection in the choledochus of 5 dogs of a little of the intestinal contents of a man 2 days dead of lightning (*foudroyant*) cholera; this small amount is diluted with a syringe of distilled water. The first dog dies in the night; the second dies at the end of 16 hours; the gall bladder is distended, the bladder is empty. The liver presents whitish spots, as if anæmic where the lobules are either more apparent by interlobular injection, or else indistinct. The small intestine is full, in the whole lower half, of a whitish pulpy matter. Comma bacilli in the ductus choledochus. The third dog is attacked on the morning of the third day, showing the following symptoms: Abundant soft stools; he seems unquiet, stands badly on his legs, totters and then lies down; frequent and profound respiration; temperature as usual,  $34.6^{\circ}$  C. Extremities cold, buccal mucous membrane anæmic. At 11 o'clock temperature  $32.5^{\circ}$  C.; preserves apparently all his senses. Occasional movement of the members indicating cramps. Died at noon. Autopsy: Intestine full, as far as the rectum, of a fluid pulp of the appearance of rice-water; gall bladder full of dark brown liquid. Blood dark fluid, no fibrinous clots in the heart. The fourth dog dies on the ninth day of peritonitis. The corpse of the fifth, which had escaped, is found later eaten by worms.

**Discussion.**—The injection of intestinal matter from a cholera victim into the ductus communis choledochus produced in the second dog choleraic symptoms, and in the third cholera symptoms were also observed. The inoculation after ligature of the ductus communis choledochus produced a beautiful culture of the bacilli of Koch.

**B. EXPERIMENTS ON THE GUINEA-PIG.**—(a) *Injection into the duodenum.*—Experiment: A young guinea-pig receives into the duodenum some intestinal contents of a cholera victim (*foudroyant* case). Temperature an hour before death is at  $24^{\circ}$  C.; death at the end of 16 hours. Small intestine gorged with fluid, partly whitish and partly greenish. Three Peyer's patches very prominent just above the valve, two higher up. Comma bacilli.

**Experiment:** Same experiment with the intestinal contents of another cholera victim, who died under the same conditions. Death of the guinea-pig at the end of 28 hours. Whitish pulp in the upper part of the smaller intestine.

**Experiment:** Same experiment on 2 guinea-pigs, with matter of the same kind, diluted with water. Recovery without any symptoms.

**Same experiment:** The animal eats and is well apparently, when after 3 days he is attacked with cramps, diarrhœa (with comma bacilli); rectal temperature,  $33^{\circ}$  C.; dies after  $1\frac{1}{4}$  hours of these symptoms. The temperature,  $34^{\circ}$  C. does not rise after death. Slightly yellow pulpy mass the entire length of the small intestine. Comma bacilli.

**Experiment:** Same experiment on 2 guinea-pigs. One is found dead the next day. Characteristic pulp as far as the middle of the small intestine, distends the lumen, bladder empty, gall bladder also empty. The other guinea-pig gets well without any symptoms.

**Conclusions.**—In 4 cases out of 7 the guinea-pigs died. There were observed the symptoms and lesions of cholera. The quantity of matter introduced was a few drops.

Inoculations practiced in the small intestine near the cæcum or below it were without result. Either the animals got well or they died without presenting the symptoms or lesions of cholera. We took care to make the operation only after a fast of 12 hours.

(b) *Injection into the stomach.*—Experiment: Four young guinea-pigs received each into the



fundus of the stomach a considerable quantity (6 cubic centimeters and more) of intestinal pulp from a victim of *foudroyant* cholera. One of these animals died in 12 hours. The autopsy revealed none of the lesions of cholera. A second died at the end of 24 hours, and presented no more characteristic results. The third showed the third day cramps in the limbs and abdominal muscles. The upper portion of the smaller intestine is found filled with whitish pulp which abounds in comma bacilla after 24 hours' incubation in a moist chamber. Finally, the fourth, which showed only diarrhoea the second day (without comma bacilli), is found dead the morning of the third day. The upper portion of the small intestine is filled with whitish pulp.

Experiment: Two guinea-pigs receive a syringeful of rice-water stools (5 cubic centimeters) into the stomach by means of the catheter. The first is found dead on the morning of the fourth day; the second, which even on the fourth day continued to have a good appetite, presented, however, a diarrhoea with abundance of comma bacilli; he was found dead the morning of the fifth day.

Experiment: Same experiment on a guinea-pig. The third day diarrhoea appeared; the morning of the fourth day, besides the diarrhoea, there was contraction of the limbs, a clonic contraction of the neck, which turned the head to the right; death followed in the algid condition a little after. At the autopsy was noted: Distension of the gall bladder, emptiness of the bladder, diarrhoeic intestinal contents as far as the sigmoid flexure of the large intestine, where there are found generally only formed faeces.

Experiment: A guinea-pig receives in the stomach the intestinal contents of a guinea-pig dying after an injection into the duodenum of choleraic stools. He shows diarrhoea after the third day, and for several days it lasts, with the presence of comma bacilli, but without any other symptoms.

*Conclusion.*—By the introduction of intestinal matter of cholera victims in the stomach, we have not succeeded in producing the results of cholera either in the dog or the hog. In the guinea-pig, on the contrary, the results have been different; they die rapidly (and doubtless then of intoxication) or else death ensues after the third or fourth day, after diarrhoea, cramps, and algidity. The lesions are those of the cholera. The experiments upon reinoculation were incomplete. Quantities relatively very great of matter were employed, and the animals were of small size, but the hypothesis of death from simple poisoning must be discarded for all the cases where the results ensued after a period of incubation of three or four days.

### III.—EXPERIMENTS OF INOCULATION WITH THE BILE OF CHOLERA VICTIMS.

The bile of cholera victims presents, as is known, striking alterations. Abundant generally, it is thick and black at the commencement, decolorized in the case of delayed death. Comma bacilli have been found in it in several cases.

Experiment I: Injection into the ductus choledochus of four dogs of fresh bile taken by aspiration with a Pravaz syringe from the gall bladder of a cholera corpse, dying in the algid stage. The first dog died at the end of 24 hours, with temperature marking 28° C. A certain quantity of serum tinged with blood is found in the peritoneum. Whitish pulp in the small intestine as far as .50 of a meter from the duodenum. Gall bladder engorged with dark bile. After 2 days in a moist chamber, the gall bladder, the ductus communis, the choledochus, and the intestines present a beautiful culture of comma bacilli with the characteristic odor.

The second dog died 3 hours later; temperature 32° C.; in the peritoneal cavity there is a little blood; gall bladder engorged; whitish pulp almost to the ileo-cæcal valve. The third dog died the morning of the third day; temperature, 2 hours before death, 24° C.; it rises again a little after death; yellow liquid in the peritoneal cavity; gall-bladder engorged; small intestine full of bilious fluid, epithelial desquamation as far as a point clearly defined above the cæcum. The dog several moments before death vomited the same bilious fluid. Almost a pure culture of comma bacilli upon the surface of the intestine after 24 hours. The fourth

dog appears to have recovered, eats the second and third day. The fourth day he is attacked with vomiting, temperature marks  $37^{\circ}$  C.; he is found dead during that day. Autopsy: A little yellowish and bilious fluid in the peritoneal cavity, gall-bladder full, bladder absolutely empty. Small intestine filled its entire length with whitish pulp. Slight injection of the ileo-cæcal valve. Doubtful comma bacilli.

Experiment II. Same experiment with the bile of the cholera corpse containing no comma bacilli even after exposure to a moist atmosphere, this bile, moreover, being from a *fondroyant* case. Two dogs were subjected to this experiment: both recovered without any morbid symptoms.

Experiment III. Same experiment with similar bile, but rich in comma bacilli, and which had killed two guinea-pigs by duodenal injection. This time the liquid was sterilized by heat. Three dogs were operated upon. They all got well without any serious results.

Experiment IV. Same experiment with the preceding bile sterilized, then exposed for twenty-four hours to the air and found to be rich in bacteria in the form of cocci. Three dogs thus treated got well without any results.

Experiment V. Injection of the bile of a cholera victim rich in comma bacilli into the duodenum of two guinea-pigs. Both died during the night or within twenty-four hours; they appeared healthy twelve hours after the operation, when they were last seen. Autopsy: Gall-bladder full, bladder empty; small intestine full of pulp of a yellowish tint in the upper half, greenish in the lower half; cæcum contains liquid fæces in the large intestine. Same alterations in both, comma bacilli in the intestinal matter.

*Discussion.*—The injection of fresh bile from a cholera victim into the ductus communis choledochus of a dog produces, when it contains comma bacilli, death after one or two days. Algidity, *enteritis* and the presence of comma bacilli are noticed; the simple injection into the duodenal ampulla kills two guinea-pigs after more than twelve hours; these present anatomical signs of algid cholera.

#### GENERAL CONCLUSIONS.

The reader who has followed this first part of our experiments, interrupted as they were by the end of the epidemic, will have observed that the symptoms and lesions that we obtained in our last attempts present characters of undeniable resemblance to cholera.

It is, after a period of three days' incubation, accompanied or not by cyanosis, prostration, algidity, spasmodic muscular contractions, and death after a few hours. There is at the autopsy: Enteritis (epithelial pulp rich in comma bacilli), emptiness of the urinary bladder, repletion of the gall-bladder.

Our conclusions are:

(1) The guinea-pig is susceptible to inoculation through the stomach, and more surely by direct injection into the duodenal ampulla.

(2) The dog can be successfully inoculated by injection into the ductus communis choledochus.

(3) The inoculation matter is that and that only which contains comma bacilli—intestinal matter, bile.

(4) The blood of cholera victims injected under the skin and into the veins produces rapid results attributable to poisoning. In an experiment upon injection in the veins, however, we have seen the animal die after three days of sickness. The question whether the blood can be a carrier of the contagion is reserved.



## EXPERIMENTS UPON THE VITALITY OF THE COMMA BACILLUS OF CHOLERA.

By Dr. W. NICATI and Mr. RIETSCH, of Marseilles.\*

Results which we published in detail in the "Arch. de physiologie" and in the "Rev. mensuelle de m d. (1885)," having warranted us in concluding affirmatively upon the specific cholerigenous nature of the comma bacillus of Koch, it became indispensable to study carefully the conditions of life of this organism—conditions which furnish information concerning the etiology and prophylaxis of cholera. In order to demonstrate the presence or absence of the microbe we have had recourse sometimes to cover-glass preparations, sometimes to the method of culture in gelatine.

## A.—VITALITY IN THE HUMAN BODY, IN STOOLS, IN CLOTHING, AND IN MOIST EARTH.

*Moment of disappearance of the bacilli in the human body.*—This point is especially important in order to decide the time when the patient or convalescent may be considered as no longer infectious.

We have examined the stools of a large number of patients who recovered. The comma bacilli were found, at the latest, on the 10th day after the commencement of the choleraic attack, sometimes we have no longer found them after the fourth day, but one should not be satisfied with these figures; negative results, however numerous, have only a relative value. We should say, however, that the comma bacilli have not been found in the evacuations which have resumed the odor, the color, and consistency of f cal matter, neither have they been found in a slowly disappearing diarrh ea which exceptionally prolongs convalescence many weeks.

We have observed the greatest care in searching for the comma bacillus in the intestinal contents of dead persons, and in autopsies; the details of these examinations will be found recorded in a table of our articles in the Archives de physiologie. We state only here that twice bacilli were met with after 11 days of the disease, which represents the longest period experienced, and that in the 6 cases of our 31 autopsies, of which the result was negative, death took place in one after 6 days, and in the others after a longer time; that which should be noted, is that a cholera patient may be contagious after 11 days of sickness.

*Material in the moist chamber or in stoppered flasks.*—Our experiments have been very numerous; they have comprised material, in the most part, from autopsies and from a large number of stools of cholera patients.

The containing vessels have been placed sometimes in the incubator, sometimes simply in the laboratory, at the surrounding temperature.

After 24 or 48 hours there is almost always development of the bacillus; one should be careful to take account of this fact in view of a diagnosis; up to this time there is a tendency to displace all other bacteria, especially those of putrefaction; afterwards however the cholera bacilli diminish rapidly, when the material begins to assume a putrefied odor; 24 to 48 hours later, ordinarily, they are no longer met with; sometimes after an interval of 24 hours we have observed in place of a pure culture absence of the bacilli.

These results have been obtained with covered glass preparations, and we have assumed the absence of the cholera bacilli when in these preparations we no longer found either characteristic comma or doubtful bacilli. It is evident that this method is not mathematically exact, and that, moreover, it would not reveal the presence of spores. It might therefore be, that when the preparations furnished negative results one might still succeed in obtaining living bacilli by successful culture. Dr. Ceci announces that he has succeeded in this; but he does not state having experimented upon the microbes thus obtained, or cultivated colonies, and in the same communication he affirms that the comma bacillus and spirilli of Asiatic cholera, as regards their morphological characters, are identical with the comma bacteria obtained by Finkler and Prior in cultivating the stools of patients suffering with *cholera nos-*

\* Rev. d'hygi ne, t. vii, No. 5, 1885.

*tras*; on the other hand, in a later communication, he admits that the injections into the small intestine of the rabbit of decomposed dejecta were followed by negative results, different from injections made with the same dejecta when fresh. The disappearance of the comma bacillus seems to be tantamount here to disinfection as regards cholera, but however this may be, the rapid disappearance of the microbe, under the influence of putrefaction is a real fact; and the following are the results of our observations upon this subject.

In no case have we seen the comma bacillus preserved after the eighth day; often it is between the fifth and sixth, more often still between the third and fourth day that it disappears; often it disappears after a shorter time—hardly 48 hours. In a stoppered flask, the preservation has appeared to us, in general, a little longer; frequently the microbe has been still abundant upon the fourth, even upon the fifth day.

In order to establish these conclusions, we shall now relate the experiments with the intestines and intestinal contents of a man, 26 years of age, dead of the disease less than 48 hours, the autopsy furnishing numerous comma bacilli.

[The sign + indicates the presence of numerous bacilli; + \* and \* \* \* bacilli in less numbers; the sign — that the bacilli are no longer found in the preparation; for the cultures, the same signs indicate the relative number of colonies of bacillus or their absence.]

- I. Piece of jejunum in the moist chamber within the incubator :
  - First day (of the autopsy made five hours after death)..... +
  - Second day..... + pure culture.
  - Third day (4 o'clock p. m. sixty-one hours after death)..... — putrid odor.
- II. Piece of jejunum in the moist chamber within the incubator :
  - At the autopsy..... +
  - Sixteen hours post mortem..... + markedly more numerous.
  - Thirty hours post mortem..... + commencement of putrid odor.
  - Sixty-one hours post mortem..... — putrefaction.
- III. Piece of the rectum within the moist chamber incubator :
  - Five hours post mortem..... + \*
  - Thirty-one hours post mortem..... + \* putrid odor.
  - Sixty-one hours post mortem, putrefaction..... —
- IV. Intestinal contents upon linen, moist temperature incubator :
  - First day..... +
  - Second day..... + more numerous, not putrid.
  - Third day..... + culture pure; no putrid odor.
  - Fourth day..... + \* \*
  - Fifth day..... — almost pure culture of straight bacilli.
- V. Intestinal test on linen in the moist atmosphere in the laboratory, commenced (October) :
  - First day..... +
  - Second day..... + almost pure.
  - Third day..... — place less pure; no putrid odor.
  - Fourth day..... + \*
  - Fifth day..... + \* \* culture almost pure, or straight bacilli, some rare comma bacilli only.
  - Seventh day..... —
- VI. (as in V).
  - First to fifth day..... —
- VII. Intestinal tests in flasks within the incubator :
  - First day..... +
  - Second day..... +
  - Third day..... + pure culture; characteristic cholera odor.
  - Fourth day..... + less numerous.
  - Fifth day..... + \* \*
  - Seventh day..... —
- VIII. Intestinal tests in flasks in the laboratory :
  - First day..... +
  - Second day..... + pure culture.
  - Third day..... + less numerous; no putrid odor.
  - Fourth day..... + no visible change.
  - Fifth day..... —
  - Seventh day..... —



*Matter preserved in linen packed away and in moist earth.*—The experiments I made in the following manner: The choleraic stool remains 48 hours in the moist temperature; it is transformed into a beautiful culture; portions of the grumous material of the size of a lentil are then placed upon small squares of linen, which are folded four times and placed in glass tubes upon a layer of common cotton non-sterilized; the linen is covered with similar cotton, the tube is then closed with a cork stopper; a series of small tubes are prepared in this manner; after some days one of the tubes is opened and the folded linen removed and moistened with a drop of sterilized water, then a little of the material is scraped off, and with it some liquid nutrient gelatine is inoculated; the latter is poured out upon glass plates with the usual precautions. The presence of characteristic colonies demonstrates that there were still living comma bacilli in the linen.

First experiment: Tubes prepared August 18. Examined:

August 25 .....	+
August 27 .....	+
August 30 .....	+*
September 1 .....	—

With the last inoculation, the observation was prolonged as late as the 5th of September. The bacilli, therefore, were observed living in the tubes for 12 days at the least, which, added to the 48 hours in the moist chambers, makes 14 days.

Second experiment: As the first, only instead of the cholera stools the intestinal contents transformed into a beautiful culture by 48 hours in the moist chamber is employed. The cotton is moistened with a few drops of water.

The tubes are prepared on the 23d of September.

September 29 .....	— putrid odor.
October 6 .....	—

A portion of the same material remained in the moist temperature within the incubator; 30th of September it still gave preparations of comma bacilli.

Third experiment: The intestinal contents from a *foudroyant* case was transformed into a beautiful culture of commas, by 24 hours in the moist chamber, prepared on the 3d of October. The matter was not inoculated into the gelatine, but was used directly to make cover glass preparations.

(a) Tubes placed in the incubator:

Examined October 4 .....	—
Examined October 6 .....	—

(b) Tubes remained at the surrounding temperature:

Examined October 4 .....	+*
Examined October 6 .....	—

Fourth experiment: The gelatine is replaced by moist earth non-sterilized; the tubes are simply corked with cotton, and kept in a very damp atmosphere—employment of the same material as in the first experiment.

Tubes prepared August 18, inoculation into gelatine:

Examined 25th of August .....	+
Examined 27th of August .....	+
Examined 30th of August .....	+
September 1 .....	+*

Next examination, and the last, was made the 5th of October—negative results.

When comma bacilli are placed under conditions similar to those of the packed linen or moist earth, they can therefore, in certain cases, remain alive 14 to 16 days at least.

*Discussion of the results.*—In the foregoing, the negative results are far from positive proofs by the culture method; in fact colonies of comma bacilli may be overlooked by the operator when they are rare and widely disseminated among a large number of different colonies, often possessing rapid development, especially as they very soon liquefy the gelatine; another difficulty is, that one can experiment only with very small quantities of matter. By the method of direct preparation (upon the cover-glass) one can bring under observation

relatively larger quantities; but the positive results become less reliable, diagnosis being very difficult for isolated comma bacilli in the midst of other bacteria; with respect to the other results, they are only valuable when there is absence of spores.

The question of the existence of spores is perhaps not yet definitely solved. Dr. Koch has never seen them formed within comma bacilli, and we have not been more fortunate. They have been described, however, by various observers: First, by M. Carillon (*Semaine med.*, 29 November, 1884, p. 462), who states that the spores resist desiccation; he speaks at the same time of the large extremity of the comma bacillus, in which it makes its appearance, but which we have never seen. It does not appear to us impossible that he may have been working with impure cultures. It is advisable without doubt to await later publications concerning these spores. Second, by M. Ferrán, of Tortosa (*Gaceta medica catalana*, 31st January, 1885). This learned investigator has pointed out at the same time other morphological conditions of the comma bacillus, such as muriform bodies endowed with genuine metamorphoses, upon which he classifies the cholera microbe with *penorospores*. According to our own researches upon this subject, it does seem possible that our friend M. Ferrán might have simply seen agglomerations, more or less globular, of the comma bacilli or non-organized matter of the culture material; besides, such metamorphoses would be phenomenal, absolutely new in the development of bacteria. Third, by M. Ceci, of Genoa (*Semaine medicale*, 18th March, 1885). The spores are seen in the center of swollen comma bacilli in the form of brilliant spheres unstained by the analine dyes; after destruction of the bacilli, the freed spores, on the contrary, color well, and are then seen in cultures of agar-agar as small spherical cocci united two together or in chains in the form of spirilli. Mixed with dried sand and exposed for 24 hours to a temperature of 37° C., they become sterile. This feeble resistance to the effect of desiccation is not the usual property of the spores of bacteria. Should not these spores, which become colored, be classed with the very short commas which we have frequently met with in our cultures and which one might take for cocci, were it not for their curvature? We are inclined to this belief.

Altogether, it is very possible that the comma bacilli may possess spores; but we do not believe that up to the present their existence has been placed beyond all dispute. In the present state of science it seems at least premature to affirm that all bacteria necessarily possess the faculty of forming spores, and that it suffices to determine the conditions necessary for their formation; but it does not seem inadmissible that such a faculty may cease to exist, or by limiting itself at least to the conditions peculiar to a bacillus acclimated for cycles in a region which is never dry, and at which the temperature does not descend below 17° C.

Whatever the solution of this question of spores may be the results of our experiments nevertheless remain, that in the human body and in the dejecta the comma bacillus maintains itself only for a limited time.

#### B.—VITALITY IN WATER.\*

During the epidemic of 1884 we made very frequently bacteriological examinations of water coming from contaminated localities. We examined spring water, well water, water from artesian wells, from canals, from the river and from lavatories; they were obtained for the most part from Marseilles, but also from Berre, Saint-Chamas, Martigues, Arles, Tarascon, Aix, Sisteron, Salon, Lascours, Omergues, Chateau-Renard, etc., a few drops of water placed upon a cover glass were evaporated in the air or in an incubator at 30° to 40° C.; the preparation was completed according to the usual method. In 145 observations just made we found 36 times the comma bacilli present, or other curved bacilli which morphologically might be confounded with them. We likewise made 23 examinations of the water of the old port of Marseilles, from the 11th of August to the 2d of November, and we obtained the same result 16 times.

But the positive proof is altogether insufficient, and it is necessary to complete it by cultures. We have many times followed this method with the water of the Old Port, and we have four times arrived at positive results; in the other attempts the results were doubtful colonies of other bacteria with a more rapid growth, having liquefied the gelatine too soon.

\* See the authors' note in the *Revue scientifique*, 28th February, 1885.



Dr. Koch had already demonstrated the presence of the comma bacillus in a tank in India around which a number of cases of cholera had occurred (*Conferenz zur Erörterung der Cholerafrage*). As it is evident that the comma bacillus is frequently met with in water; as it has been placed beyond doubt by numerous observations, even anterior to any notion of the pathogenic rôle of microbes, that water is at least one of the principal agents for the propagation of cholera, it appeared to us interesting to make experiments concerning the vitality of the comma bacillus in water. Its family relations with the essentially aquatic spirilli creates the assumption for it of a certain longevity in that medium.

There was a local interest for Marseilles that these examinations should not be limited to fresh water, but should also be extended to the sea water, and especially to that of our port where the numerous sewers empty.

This is a sort of briny water, something like that of the delta of the Ganges, where Dr. Koch has placed the natural habitat of the comma bacillus—the Sunderbund. The Sunderbund is a strip of inhabited land, with a fauna and flora very rich, which receives the dejecta of the dense population crowded together upon the delta; it is never dry, the sea encroaches upon it, and the fresh waters of the Ganges and Brahmapootra there mix without cessation with the water of the sea.

The experiments were performed in the following manner: Glass flasks of a capacity of one-half to one liter were three-fourths filled with the water filtered through paper, then plugged with cotton. They were kept in a marine bath of boiling water for an hour and a half to two hours; they were reboiled on the next day, and then again on the next. With a capillary tube a few drops of pure culture, very rich in comma bacilli, were introduced into this sterilized and cold water. The flasks replugged at once and shaken, in order to distribute the bacilli through the whole mass, were exposed to the temperature of the laboratory, one window of which remained constantly open, except a few hours a day, when the laboratory was warmed by two or three jets of gas (experiments performed in winter). At variable intervals a few drops of this water were removed from the capillary tube and mixed with liquefied nutrient gelatine; then this gelatine was poured into small glass vessels, which subsequently were placed in the incubator. Inasmuch as the choleraic contagium maintains its life in water, one should obtain colonies of the comma bacilli in the gelatine; the evidence furnished by this method must be reliable even in cases where the spores would exist or more accurately would be produced under the conditions of the experiment.

We have several times made a direct examination of the water, and whenever colonies were developed the cover-glass preparations showed comma bacilli taking the analine stain, but showing an indication of the formation of spores.

First experiment: Distilled water inoculated the 17th of November. Examinations:

November 18.....	+	November 29.....	+
November 22.....	+	December 4.....	+
November 23.....	—	December 7.....	+
November 27.....	—	December 10.....	—

From November 17 to December 7, equals twenty days.

Second experiment: Water from the canal of Marseilles inoculated the 17th of November.

Examinations:

November 13.....	+	November 29.....	—
November 22.....	+	December 4.....	—
November 26.....	+	December 7.....	—

From the 17th November to the 26th of November, equals nine days.

Third experiment: Water from the Marseilles canal, inoculated December 6. Examined:

December 15.....	+	December 19.....	+
December 16.....	+	December 20.....	+
December 17.....	—	December 25.....	—

From the 6th to the 20th of December, equals fourteen days.

Fourth experiment: Water from the Marseilles canal, inoculated December 6. Examined:

December 19.....	+	January 7.....	+
December 20.....	+	January 13.....	+
December 29.....	+	January 25.....	—
January 2.....	+		

From December 6 to January 13, equals thirty-eight days.

Fifth experiment: Water from Marseilles canal, inoculated December 6. Examined January 21 (46 days) +; January 21, injection into the duodenum of 2 guinea-pigs, observed during 8 days —

Sixth experiment: Sea water obtained about 4 kilometers from the ports near the Isle of Pomegues, inoculated November 7. Examined:

November 10.....	+	December 10.....	+
November 22.....	+	December 15.....	+
November 26.....	+	December 20.....	+
November 29.....	+	December 25.....	+
December 4.....	+	January 15.....	+
December 27.....	+	January 16.....	—

From the 7th of November to the 5th of January, equals forty-nine days.

Seventh experiment: Water obtained several kilometers from the Marseilles canal, near the Island of Rion; inoculated the 12th of December. Examined:

January 29.....	+	February 1.....	+
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From the 12th of December to the 1st of February equals fifty-one days.

This experiment was not completed; the cultures were too impure.

Eighth experiment: The same water inoculated also on the 12th of December. Examined:

February 6.....	+	February 22 (72 days).....	—
February 14.....	+	February 26.....	—

From the 12th of December to the 14th of February, equals sixty-four days.

Ninth experiment: The same water inoculated on the 12th of December. Examined February 28 (78 days); result negative.

Tenth experiment: Water from the old port of Marseilles, inoculated 16th of October. Examined:

October 23.....	+	December 4.....	+
October 26.....	+	December 7.....	+
October 28.....	+	December 10.....	+
October 31.....	+	December 15.....	+
November 1.....	+	December 20.....	+
November 6.....	+	December 23.....	+
November 17.....	+	December 25.....	+
November 18.....	+	January 5.....	+
November 22.....	+	January 6.....	—
November 26.....	+	January 22.....	—
November 29.....	+	January 25.....	—

From the 16th of October to the 6th of January equals eighty-one days.

Eleventh experiment: Same water inoculated December 6. Examined:

January 21 (46 days).....	+
February 26 (82 days).....	—

Twelfth experiment: Same water inoculated December 5, 1884; the flask was opened for the first time February, 1885; result —.

Thirteenth experiment: Bilge-water from an iron steam-ship coming from Japan without having emptied its bilge en route; inoculated December 12, 1884. Examined:

December 16.....	+	January 2.....	+
December 20.....	+	January 7.....	—
December 25.....	—	January 13.....	+
December 9.....	+		

From the 12th of December to the 13th of January equals 32 days. We did not continue this experiment.



Fourteenth experiment: Bilge-water of a wooden ship coming from the colonies, inoculated December 19. Examined:

December 25..... —  
January 2..... —

Thus in still water the comma bacillus was able to live 80 days; in the canal water, 38 days; in the sea-water, 64 days; in water of the old port, 81 days; in bilge-water, 32 days.

In these experiments the cultures ordinarily at first only consist of colonies of the comma bacillus; but when the flasks had been opened several times they became very impure; thus for water of the old port (tenth experiment) the cultures were impure from the 26th of October. Many times when we saw that the gelatine was threatened with liquidity by other bacteria before the colonies of the comma bacilli were quite characteristic we made a new inoculation with one or more of the colonies, which were probably cholera bacilli; the colonies thus examined were always controlled by microscopic examination.

*With respect to the water of our ports.*—These experiments were very far removed from natural conditions; the association with other micro-organisms, which plays so great a role in the destruction of the comma bacilli, was almost always suppressed in the first phases, and sometimes even during the entire experiment when the few repeated examinations were made only after a long lapse of time; second, the comma bacillus is adapted to countries where the temperature never descends below 13° C.; the conditions may be favorable in the water of our ports during the heat of summer, but when the temperature falls the usual inhabitants of this water, acclimated to this change, will resume their predominance and will cause the microbe of cholera to disappear; third, in our flasks contamination only resulting from exposure to the air, it is therefore probable that the associated bacilli were not the same, and certainly not as varied as in the water of our port; fourth, the temperature, however, having been generally low, the vitality active, especially the multiplication of the bacteria must have been very much retarded; fifth, the temperature was pretty variable, the condition very different from that existing in large quantities of water; sixth, a circumstance, evidently unfavorable, was nutritive substances very diluted and a long time heated to 100° C., making them less assimilable and smaller in quantity.

It would therefore be difficult to deduce any rigorous laws from the preceding experiments as to the mode of life of the comma bacilli in the water of our ports, but what may be deduced from them very certainly is that the cholera contagium preserves its vitality a long time in water, especially in salt-water, and that the greatest precautions should be taken with respect to the first cases of an epidemic.

*With respect to bilge-water of ships.*—In one case (13) comma bacilli survived for 32 days at least, in the bilge-water of a merchant steamer (iron); it appeared that the bilge was not emptied a single time during the voyage of more than 40 days; this water contained 34.30 grams of the chloride of sodium per liter, no iron; it was of amber color, of a stale odor, quite disagreeable but not at all putrid and not at all moldy.

In experiment 14, bilge water from a wooden ship was the subject of experiment. This water is a mixture of that from the bilge and machinery; it had been emptied and replaced with clean water before the arrival in port; but at sea a certain quantity of this water always remains in the hold.

During the sterilization it had formed an ochre-color deposit, it had slightly acid reaction or still contained iron in two forms of oxidation; this water had been sent us by the professors of the school of Toulon, who very kindly also gave us information concerning the chances of the contamination of this water with the bilge. According to these gentlemen, this certainly could not take place in ordinary cases, but it ought not to be considered impossible.

In merchant ships the bilge is accessible through a trap, very easy to remove, and the experiment (13) shows that the cholera contagium could be easily preserved alive in this medium during a voyage from India to Europe; it could subsequently be spread by means of the workmen occupied in the bilge during the unloading, or by means of the port water itself.

If the bilge-water should be emptied into it, as is generally done, the comma bacilli, if they find nutrient material, may multiply, even at once or after a shorter or longer time, if importation takes place at a time of year when the water is cold.

When there has not been a case of cholera during the voyage, an importation by this means would appear to us much less probable than by the personal effects of sailors who had died from cholera at Siagon.

Propagation of cholera by fresh water is not at all questioned; stagnant or still water and that of gentle eddies will present more danger than rivers or streams in which the infection is very diluted and rapidly carried away.

#### C.—VITALITY IN ARTIFICIAL MEDIA.\*

We have investigated the vitality of the comma bacillus under divers conditions of external media in order to determine the most unfavorable, that is to say, the most certain to insure disinfection.

Here, as with the succeeding experiments, we have proceeded by inoculating nutrient gelatine and considered the disinfection as accomplished when the inoculation no longer produced colonies; we have proven that it is impossible to regard immobility of the bacilli as a characteristic indication of disinfection not only because of errors which might be occasioned by the Brownian movement, but also because of comma bacilli, which have apparently lost their motility, but by that have not necessarily become incapable of reproduction in a nutritive medium.

(a) *Chemical agents.*—The culture media are always alkaline, and as a consequence partially neutralize the acids, and for the same reason and by their nature besides (complex nitrogenous principles) they precipitate the metallic basis and form with them salts of a double combination, inactive or more or less active than salts themselves; in order to avoid as much as possible these reactions, it may cause error concerning the relative energy of the chemical agent employed. We have always operated by adding 10 to 20 cubic centimeters of the fluid disinfectant, a few drops only (45) of a culture (bouillon or gelatine) very rich in comma bacilli, that would allow the actions to take place during fixed times, ordinarily very short; at the end of 5, 10, 15 minutes, etc., cull a few drops of the mixture where inoculated into the gelatine previously liquefied and cooled; the latter would be immediately poured upon a glass sterilized plate or into a small sterilized dish. The glass plates were placed in a moist temperature, and the dishes, with their covers, were at once placed in the incubator and observed every day, usually for six days at least.

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#### ON THE ETIOLOGY OF ASIATIC CHOLERA.

##### A PRELIMINARY COMMUNICATION.

By A. CECI and E. KLEBS.†

At the end of a long communication these authors present the following conclusions:

I. In examining the dejections of cholera patients or the intestinal contents of the cadavers of persons rapidly killed by the disease, the comma bacilli are always found; sometimes they are found in small numbers and are absent in some stools. True Asiatic cholera may, however, be present even in the latter case. We are unable to say whether the bacilli in question might be found in these cases by successive cultures. When there are very few of them and at the same time many other schizomycetes, it is not probable that pure cultures are obtainable even by following scrupulously the method of Koch.

II. When the commas are found in the dejecta, they are always mixed with the short spirilli, which result from the union of two or three bacilli.

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\* See the authors' note in the *Revue scientifique*, 24th November, 1884.

† *Archives italiennes de biologie*, Tome VI, Fasc. 1, 1885.



III. In keeping the dejecta containing the comma bacilli for some time at the ordinary temperature the following will be observed :

(a) On the second day the spirilli increase considerably in numbers and length;

(b) On the third and fourth day one obtains almost a pure culture of spirilli, some of which are of extraordinary length, having 10, 20, and 30 curves;

(c) On the following days the spirilli rapidly decrease in numbers, and are gradually replaced by spherical, oval, or straight bacteria of putrefaction.—(Ceci.)

IV. The commas can obviously arise by division of the spirilli; in dejecta which are kept one distinctly sees spirilli in process of division. Some are seen divided into five or six bacilli at one end, whilst the continuity of the other end is uninterrupted. Up to the present spores have not been found in the spirilli.—(Ceci.)

V. During the formation of the spirilli the fæcal matter remains alkaline or neutral, and this reaction is maintained even till advanced putrefaction, when the spirilli and comma bacilli disappear.—(Ceci.)

VI. The mycotic invasion of cholera is strictly limited to the intestine; the blood, the liver, the spleen, the kidneys contain neither comma bacilli nor microbes of any kind.

VII. The comma bacilli are likewise absent from the expired air of patients in the algid period.—(Ceci.)

VIII. During this period there exists no morphological alteration of the blood, save an increase of white corpuscles and a darker color of the red globules, due to the cyanosis.

IX. On subjecting completely decomposed dejecta in which one can no longer find any comma bacilli to successive cultures, one still obtains even pure cultures of these microbes.—(Ceci.)

X. In the *foudroyant* cases, the symptoms, the death, and the lesions of the organs can not be explained by the very slight lesions of the intestine. In very early autopsies, in which the epithelium is still *in situ*, there are no comma bacilli at all in the glands of Lieberkühn, although the mucous membrane may be densely infiltrated with lymphatic cells.—(Klebs.)

These results are obtained as well by microscopic examination as by the culture method.

XI. The most marked anatomical lesions are met with in the kidneys; on simple inspection they present only an abnormally pale color of the cortical substance. But by examining sections stained with gentian-violet the following remarkable lesions are to be noted: the tortuous tubes are not stained, or they readily give up their color to alcohol so easily that by the ordinary treatment they remain uncolored. The nuclei have entirely disappeared, or at least they contain only traces of the material which stains. The cellular substance is greatly swollen, slightly cloudy, and at the acme of the morbid process it completely fills the lumen of the tubules. It is a coagulation necrosis of which one can follow the progress in one and the same tubule. The necrosis attacks the epithelia, which, according to the researches of Heidenhain, excrete the specific components of the epithelia of the tortuous tubules and those of the widest part of the ascending branch of Henle's loop.—(Klebs.)

It is probable that in Asiatic cholera there is produced a toxic substance which attacks the cell-protoplasm; that this substance, perhaps formed in the intestine through the agency of the spirilli, is absorbed; that when it comes in contact with the tissues diluted it produces an atrophic condition (in the spleen, liver, cutaneous tissues, etc.); whilst concentrated it leads directly to necrosis, as in the kidneys.

A series of grave nervous symptoms is due without doubt to uræmia, as clinicians have frequently affirmed.

The arterial thrombi, which go sometimes to the extent of necrosis, may be produced by a similar alteration of the walls of the vessel, as well as the spots of the conjunctiva, of the pericardium, of the epidermis, etc., lesions which one had been in the habit of attributing to the loss of heat by the intestinal dejecta, but which we should at present regard as the consequence of a diminution of the vital activity of the cells. This view is quite confirmed by the observations made in cholera *sicca*, a form which predominated at Genoa.

Our later researches will aim to demonstrate the existence of the toxic substance, which produces the lesions pointed out.

XII. One of us (Ceci) can affirm that the comma bacilli and spirilli of Asiatic cholera, as regards their morphological characters, are quite identical with the comma bacilli and spirilli obtained by cultures of the stools of *cholera nostras* patients by Finkler and Prior; the other (Klebs) has seen the same forms of spirilli in the diarrhoeal discharges of a pneumonia patient.\*

#### ON THE CHOLERA IN GENOA, 1884.

By KLEBS.†

Klebs gave a very instructive account of the mode of origin of the epidemic of 1884 in Genoa, of which the following is an abstract:

Official reports of the outbreak of cholera in Genoa, concerning the location of the first 300 cases of cholera with reference to the supply of drinking water, make a very significant showing, as graphically indicated in tabular form in orderly groups of 50 each.

##### *Analysis of distribution of first 300 attacks with reference to water supply.*

Groups of fifty cases occurring in succession.	The dwellings of the sick were supplied with water from the aquaducts of the:				
	Aqua Nicolay.	Galiera.	Aqua civico.	Rain cisterns.	Unknown.
From 30 August to the 25 of September.....	48		2		50
From 25 of September to the 26 of September..	43	2	2	1	50
From 26 of September to the 27 of September..	45		1	1	50
From 27 of September to the 28 of September..	39	1			50
From 28 of September to the 29 of September..	40	1	3		50
From 29 of September to the 30 of September..	41	2	3	3	50
Total attacks.....	256	6	11	5	300

Thus it is seen that of 278 cases, whose use of water could be established, 256 or 92 per cent. were consumers of the Aqua Nicolay water.

The supply of the Aqua Nicolay is as great as both of the others together. Thus the probability of being attacked by cholera in the case of the consumers of the water of the Aqua Nicolay Company, was thirteen to eighteen times greater than was the probability of an attack among those who used any other water.

So striking were these positive facts concerning the general distribution of the disease that the supply of the Aqua Nicolay water to the "Albergo di Poveri" (almshouse, with 1,200 inhabitants,) and to the "Manicomio" (insane asylum) was interrupted on the 20th of September. In the former, no case of cholera appeared; in the latter, there was no epidemic, although a couple of cases were smuggled in. Both of these public institutions lay in the lower and densely populated part of the city, not far from the river Bisagno in a region where numerous cases were observed and which by no means could be called the healthiest.

Finally, in certain streets, one side thereof supplied only with the Aqua Nicolay water, the sick were found to be limited to the dwellings of that side.

The aqueduct of the Aqua Nicolay Company brought the water of the river Scrivia, an affluent of the Po, from Busalla, a neighboring mountain village on the route of the Alexandria-Genoa railway, into the city of Genoa.

The water of this mountain brook rushes, during most of its higher course, over small rocks, which fill the bed of the stream, and upon which all the inhabitants spread their wash out to dry and bleach, as any one who has traveled this route by day knows.

Now cholera appeared in Busalla eight to nine days before the outbreak of the great epidemic in Genoa, and it is probable that, through the washing of clothing in the Scrivia, and spreading them out to dry on the rocky bed of the brook, cholera germs may have reached the water of the Nicolay aqueduct.

\*Genoa, October 25, 1884.

†Correspondenzblatt f. schweizer Aerzte, 1884.



Klebs, who with A Ceci of Genoa, conducted a bacteriological investigation of the cholera in that city during 1884, as has been already noted, after having related the foregoing account of the invasion, which the reader would do well to compare with the history of cholera in Genoa during 1884, given by Maragliano in the section of this report devoted to the epidemic in Italy, thus expressed his view of the *requirements* for the diagnosis of cholera asiatica:

- (1) Always, the symptoms of the disease and its presence in the country.
- (2) Further, the demonstration of the comma spirilla in the evacuations is of great significance, if they are found in large numbers and if, under sufficiently strong magnification, they correspond to the usual forms of this microbe as well as present characteristic cultures.
- (3) Failing in the last, which may indeed happen by reason of very small numbers of the spirilla, the case remains doubtful; the same is true if the spirilla and commas observed exhibit certain slight deviations from the normal forms.
- (4) It need scarcely be remarked that, in order to avoid danger, the cases pronounced doubtful because of the uncertain results of the examination must be isolated and kept under observation until the doubt is removed.

This author also advanced the following opinions, which are well worth the reader's comparison, with considerations and observations by several investigators set forth in another part of this report, concerning the production of a poisonous alkaloid during the development of the comma bacilli of Koch in certain of their culture media, and concerning the poisonous qualities of the intestinal contents of cholera patients.

Klebs says: "It (the cholera) is in striking contrast to the other acute infectious diseases, that in this disease the spleen especially appears notably small, flabby, and anæmic. On the contrary, we are accustomed to regard the swelling of the spleen as a mark of differentiation between *intoxication* (poisoning) and the infectious processes, as, for example, in the differential diagnosis between acute yellow atrophy of the liver and phosphorous poisoning."

#### ETHIOLOGY OF ASIATIC CHOLERA.

By Dr. ANTONIO CECI, of Genoa.\*

Arrived at Genoa at the commencement of the recent epidemic of cholera, I was commissioned by Baron Podesta, mayor of that city, to make a microscopic analysis of divers specimens of water, collected under the authority of the municipality, in the houses where the first cases of cholera appeared. Although I had been occupied for several years with bacteriological studies, I had had no personal experience with cholera; in order to facilitate the accomplishment of my researches the municipal council placed at my disposition the cadavers at the St. André and La Force Hospitals.

I performed 23 autopsies at the St. André Hospital, and conducted four in the Lazaretto La Force. Several physicians assisted me at the laboratory of St. André; Dr. Aug. Bonhomme, my pupils Lucatello and Simonetta, assisted me during the whole time of my researches, which lasted three months; during the last month another student, M. Risso, joined them.

My master, Professor Klebs, of Zurich, was at work with me for a week in my laboratory; finally Professor Finckler and Dr. Prior, of the University of Bonn, came for a fortnight to study a question which especially interested them.

My studies upon cholera may be divided into three parts: (1) Anatomico-pathological observations; (2) researches concerning etiology; (3) microscopic analysis of the various specimens of water furnished by the authorities of Genoa, especially with regard to lower organisms.

The second point had already formed the subject of a previous communication, published October 25, in conjunction with Professor Klebs. My engagements as practitioner and professor have up to the present time prevented me from bringing together in a memoir a full

\*Ann. de la soc. méd.-chir. de Liège, 5 fév., 1885.

account of our researches; fearing that this postponement might be prolonged, I have thought it advisable to present here, *en résumé*, the additional results which I have obtained. I must offer the observation that during the first ten days of my investigations I had at my disposition a Hartknack microscope only, the strength of the objective of which was No. VIII; this took away a certain force from the negative results which I have recorded respecting the presence of the comma bacillus in the intestinal contents in the first observed cases of cholera. Later I made use of an excellent Zeiss, with homogeneous emersion one-twelfth and one-eighteenth, and from that moment the microscopic examinations always furnished positive results.

At the beginning I occupied myself especially with the autopsies of cholera patients, with the microscopic examinations of the stools and intestinal contents, and with experiments upon animals; later with cultures, and finally with analyses of the water.

The results which I publish in this note were obtained before the middle of December, 1884; I related them in part before a meeting of the medical profession held in the Pammatone Hospital, December, 12, 1884, and I there demonstrated my microscopic preparations.

#### OBSERVATIONS.

(1) Food and drink contaminated by fresh and putrified choleraic matter (vomit, intestinal contents) did not produce any effect in the animals to which they were fed (dogs, rabbits, chickens, guinea-pigs, monkeys, and rats).

It was altogether otherwise with man, for I have witnessed a sad experiment in St. André Hospital upon my excellent servant, Pasquilla Baldissarelli; notwithstanding my advice he had a habit of keeping his breakfast upon an *étagère* where we placed our material for study, such as dejecta, vomit, intestinal contents, etc. The shelves of this *étagère* were infected by the material which was placed upon it. It was probable that Pasquilla thus each day took into his stomach a certain quantity of infectious material which, for a while, remained inoffensive, thanks to the perfection of the functions of his stomach. It was after a repast of abnormal amount that the infection occurred; cholera manifested itself in the evening by a profuse diarrhoea, and the next day Pasquilla reached the laboratory already cold and voiceless; he died the fourth day.

It should be remarked that at this time the epidemic had ceased at Genoa several days previously.

(2) Direct injection into the small intestine of fresh or old choleraic dejecta, and of recent or decomposed intestinal contents obtained from cholera corpses did not give positive results in rabbits, dogs, guinea-pigs, monkeys, and chickens.

(3) But if this injection was preceded by ligation of the billiary duct (experiment of Nicati), death was obtained in two or three days (some rabbits). The intestine of the animals thus treated at the autopsy appeared distended with a grayish liquid similar to rice-water, containing a large number of comma bacilli.

I obtained positive results in a chicken by the simple injection of faecal matter into the small intestine.

(4) When the injecta, or material collected from the intestines, had undergone advanced putrefaction, direct injection into the intestines frequently did not give in rabbits anything but negative results, even when ligation of the hepatic duct preceded the operation.

(5) I obtained cultures of the comma bacillus and of the cholera spirilli perfectly pure by following the method of Koch for plate cultures, but, on the contrary, it was difficult for me to separate the choleraic bacilli from other bacteria by following solely the method of successive cultures, even when making new cultures every twelve hours.

I found it useful in all the cases to maintain the temperature of the incubator between 20° and 30° C.

(6) In pure cultures of the comma bacillus made in nutrient gelatine the latter became liquid without the production of any putrefaction; if agar-agar is used and care is taken to disseminate the germs uniformly throughout the whole extent of the nutrient mass, colonies form which are round, miliary, similar to round skull-caps, colorless or of a very light grayish-



white, having no fluorescence; their appearance is so characteristic as to permit them to be distinguished by the naked eye from the colonies of all other bacteria which I have thus far studied. Later the colonies fuse together, forming a mass transparent or slightly opalescent, with a raised surface in the middle of the culture. Such is the most typical form of the cultures of comma bacilli. Upon agar-agar, when the cholera bacilli develop in a state of purity, one does not observe, even after a considerable time, any putrefaction. The colonies are characteristic enough to render them easily recognizable, even in a very impure culture. Certain cultures exhale a very aromatic odor, recalling that of acacia blossoms.

(7) If one studies agar-agar cultures under certain conditions for a certain length of time, varying from 20 days to 2 months, one sees the transparent or very slightly grayish salient patches which the colonies of cholera bacilli form to disappear little by little; the middle of the culture becomes transparent to such a degree that if it be examined by transmitted light no longer can any trace of the growth be distinguished, whilst, on the other hand, by reflected light, the surface appears slightly velvety.

(8) The cholera bacilli develop without any appreciable modification in culture media, such as bouillon and nutritive agar, even when they have already undergone putrefaction through the development of different bacteria, provided, however, that the media be fully sterilized by a prolonged boiling (six hours) before use. It is evident from this that the fixed principles developed under the influence of putrefaction are not opposed to the growth and development of cholera bacilli.

(9) The injection into the small intestine of rabbits or guinea-pigs of a pure culture from two to four days old (twenty-second generation or more) without ligature of the hepatic duct, has produced in two or three days the death of most of the animals subjected to the experiment; on the other hand, it was without result in the dog. In the sick animals, one observed a certain time after the operation a decided aversion for food, then lividity of the ears and of the mucous membranes, considerable coldness, lowering of the rectal temperature of rabbits to  $38^{\circ}$ ,  $37^{\circ}$ , and  $36^{\circ}$  C., and diarrhoea.

At the autopsy the lungs were found normal; the heart and large vessels full of dark fluid blood; the spleen firm, with a roughened capsule; the small intestines distended with a grayish liquid, similar to rice-water, entirely void of biliary pigment; the mucous membrane of the small intestine pale, the solitary follicles very visible in places; the Peyer's patches normal. The large intestine contained only a little semi-fluid material, or none at all. The gall-bladder was distended with bile. The kidneys were more or less congested. All of these lesions correspond to what one finds in cholera of a rapid march.

In a guinea-pig dead the sixteenth day after the operation there existed a considerable hyperæmia of the whole small intestine, with a softening of the mucous membrane, these lesions becoming very intense in the ileum, the intestinal contents were sanguinolent, the lungs and kidneys full of blood (lesions of prolonged cholera or secondary lesions).

(10) The rice-water intestinal contents of the animals (those dead from cholera) consisted almost always of the cells or cellular flakes of the intestinal epithelium suspended in a serous fluid. The comma bacilli were found in this in great abundance, without the number of these parasites appearing to be proportional to the pathological process. By preserving this material at the external temperature ( $12^{\circ}$  to  $16^{\circ}$  C.) a large number of very long spirilli which disappeared on the fourth day were found in it at the end of the second or third day.

(11) No kind of parasites were found in the blood or in the substance of the liver or spleen of the animals which died after the injection of cultures of the cholera microbes into the small intestines if the autopsy had been made immediately after death; the culture media inoculated with these products (blood or organs) remained constantly sterile.

(12) In cultivating the intestinal contents of animals dead after injection of pure cultures of the cholera microbes one obtains comma bacilli in great abundance.

(13) Injecting the characteristic intestinal contents obtained from rabbits dead of experimental cholera directly into the intestine, I obtained the same symptoms of cholera and death.

(14) By cultivating the intestinal contents of rabbits dead of cholera until the comma

bacillus is isolated and then injecting the pure cultures of this microbe into the intestines of rabbits or of Guinea pigs I again obtained the clinical symptoms and characteristic anatomical lesions of cholera.

(15) In pure cultures of the cholera bacilli one sometimes under conditions not yet well determined observes swollen comma bacilli which present in their center a spherical element highly refractive, which, contrary to the rest of the bacilli, does not stain by aniline. This is the *cholera spore*. Among the conditions which favor the appearance of these spores, age of the cultures, comparative dryness of the medium and lowering of the temperature may be mentioned.

In pure cultures upon nutrient agar, having undergone the modifications indicated in paragraph 7, microscopic examination shows in places only some debris of the comma bacilli or of the spirilli, which in certain cultures are not even found any longer; but, on the contrary, one always finds in them small spherical elements (cocci and diplo-cocci), and even chaplets of round cocci disposed in a spiral line. These organisms color very well by methyl violet and by Weigert's fluid. They are the cholera spores which may form within the comma bacilli, as also in the spirilli of cholera, and become free by the destruction of the elements within which they are generated. Thus one finds large masses in cultures upon agar when these cultures become transparent and appear sterile.

(16) By cultivating these cocci and diplo-cocci, as also the spiral chaplets, one obtains perfectly pure cultures of the cholera bacilli.

(17) The choleraic spores, mixed with sterilized sand and exposed to a temperature of 36° C. after a complete desiccation for 24 hours, then inoculated into fluid cultures, have remained sterile for an indefinite time (20 days).

(18) In preparing watery extracts of the viscera (brain, liver, spleen, kidneys) removed soon after death from subjects dead of cholera of rapid course and injecting them into rabbits and dogs under the skin or into the peritoneal or the pleural cavity one does not obtain any result, even when the quantity injected is large. Neither do these injections produce local inflammation.

(19) Intra venous injections of the same material have not given positive results.

(20) Intra venous injection even in large quantity of the first urine passed by choleraic patients after the algid period does not produce any special effect upon rabbits.

#### CONSIDERATIONS.

Experimental pathology now proves that the cause of Asiatic cholera resides in the presence of choleraic bacilli or spirilli. The results obtained at first by Nicati in combining the direct injection of choleraic dejecta into the small intestine of the rabbit with ligation of the hepatic duct have received numerous confirmations. I have obtained the same results by repeating these experiments upon the rabbit; Koch has even succeeded after simply injecting into the small intestine of the guinea-pig a pure culture of the comma bacillus in the fourteenth generation. Finally, I have had the same success by injecting directly into the intestine of guinea-pigs and of rabbits pure cultures of the twenty-second generation.

As my colleagues who have witnessed my experiments can verify, the animals thus infected present not only at the autopsy the anatomo-pathological lesions of Asiatic cholera, but during life also the most characteristic symptoms of this affection—cyanosis and coldness. The extreme smallness and the firmness of the spleen, moreover, permit the exclusion of every idea of a septic infection, and the absence of parasites in the blood and in the fluids of the organs of the animals experimented upon, a fact demonstrated by the negative results of attempts at culture of these products, confirms this notion.

It is certain that death has not been produced by a complication connected with the wound of the operation. As proof of the very minute antiseptic precautions which I have always employed in my vivisections, I would mention the absence of abnormal symptoms in the numerous animals in which the choleraic infection did not at all develop, that in certain of



them the peritoneal cavity had been opened as many as three times at variable intervals in order to permit the direct injection of fæcal matter into the intestine, and finally the constant absence of peritonitis and of peritonitic adhesions in all the autopsies. I can therefore affirm that the exact results which I have succeeded in obtaining rest upon rigidly scientific experiments.

I should add to this that in preparing pure cultures from the intestinal canals of the animals dead after these experiments and injecting them into the small intestine of other animals I obtain exactly the same results. Finally, the anatomo-pathological picture of the choleraic infection thus produced is so much the more complete, as one may obtain the lesions of cholera of a rapid progress, and those of protracted cholera with various secondary alterations.

I believe that, with the exception of anthrax, there is no infectious disease the parasitic nature of which has been experimentally demonstrated with as much exactness as that of Asiatic cholera.

The infection of cholera is exclusively localized in the intestine, and at the beginning particularly in the small intestine; the agent of this infection, the cholera bacillus, penetrates but little into the depths of the tissue of the animal organism. When the bacillus, overcoming the obstacles in the way of its arrival in the intestine, notably the action of the gastric juice and of the bile, finds at length the conditions favorable, it produces a series of phenomena which, as I am profoundly convinced, should be considered as depending upon reflex nervous action.

There is at the commencement a permanent contraction of the walls of the hepatic duct of such a degree that the bile, not being able to empty into the duodenum, accumulates in the gall bladder, which greatly distends; then follows a more or less considerable transudation of serum, and an extremely extensive desquamation of the epithelial cells, whence the diarrhœa and vomiting. The appearance of the vomit and the dejecta is characteristic.

Very soon the nervous disturbances pass beyond the abdomen; one then observes aphonia, spasmodic contraction of the arteries; then cyanosis, cramps, suppression of the urine, fall of temperature. Up to that point, the pathological process has remained pure, if I may so express myself, and most frequently it is sufficient to occasion death. If the patient survive, one then sees the manifestation of the effects of the more or less prolonged suspension of the life of the tissues, of considerable losses of fluid which the organism has experienced, even sometimes verging upon desiccation; the peripheral arterial circulation remains insufficient, the excrementitious products are accumulated within the organism by reason of the temporary cessation of urinary secretion, etc. Such is the typhoid form in which very diverse disturbances are to be considered.

That the cholera bacillus acts by secreting a poison, which, absorbed by the blood, may produce the grave phenomena of cholera and death, as Koch and Klebs have been disposed to admit, appears to me not very probable. In my opinion, the action of the bacillus is purely local, perhaps even mechanical, and troubles which it produces are of a nervous reflex nature. In fact, at the very commencement, augmentation of the gastro-intestinal excitability is observed: vomiting, diarrhœa, spasmodic contraction of the hepatic duct, etc. Then enervation becomes weakened and extinguished, so to speak, in the intestine, which becomes the seat of circulatory disturbances: intense hyperæmia, stasis, reaching the point of partial or even total gangrene of the mucous membrane.

It is to be noted that these latter lesions are evolved without betraying themselves by any symptom.

I have been struck with the close analogy which the clinical picture of the algid period of cholera presents to the ensemble of the symptoms which are observed in cases of death from surgical collapse (shock) following a strangulated hernia or a grave operation performed upon one of the abdominal organs, etc.

I meet with this same anxiety of countenance in cholera, the same haggard expression, those glassy deep-set eyes, the extremely frequent or imperceptible pulse, the rough, cold skin

covered with a clammy sweat. The Asiatic disease, however, possesses characteristics which are peculiar, the cyanosis, the more pronounced aphonia, the more marked smallness of pulse may indeed entirely disappear.

To explain by the thickening of the blood and the desiccation of the tissues the phenomena in question, would be so far as the special case of the epidemic of Genoa is concerned to place one's self in opposition to the facts. In many patients scarcely any diarrhœic evacuations and vomiting occurred; at the autopsy the whole mass of the intestinal contents did not measure a half liter; the mass of the blood had not undergone appreciable diminution; the blood was very fluid, although it was pretty dark.

On the other hand, can not the organism stand very considerable losses of fluid without experiencing great inconveniences? Without doubt, in certain forms of cholera accompanied by a very profuse diarrhœa desiccation of the tissues exists; but this lesion is not sufficient to explain the strange phenomena of choleraic infection, for by itself it produces only a small effect or none at all, whilst it may be absolutely absent in the most malignant forms of this terrible disease.

It is in the nervous disturbances which one should seek the explanation; in the exaltation, the perversion of the functions of the intestines, and later sometimes we have the lesions of innervation, phenomena which are never absent and which at first are of reflex origin.

Furthermore, it is notorious that diarrhœa can be produced also by great fright; every intelligent physician has observed in an epidemic of cholera the influence of moral causes in general and especially fear upon the spread and the course of the epidemic; the remedy universally employed for checking and for arresting in its commencement the choleraic infection, laudanum, acts precisely in diminishing the excitability of the intestine; the cold baths, friction with ice, which at times render undoubted service, act, as in the case of shock, by exciting the peripheral nerves.

It is probable that the cholera bacilli stimulate the nervous terminations of the intestinal mucous membrane whether mechanically or by producing through fermentation of the intestinal contents an irritant substance of local action. It is known, moreover, that slight irritations uniformly repeated and continued for a long time act by depressing the nervous system to a degree which would not be supposed at first from their feeble intensity. It is thus that repeated slight pricking is sufficient in certain cases to produce profound sleep. The penetration of the *izodes ricinus* into the skin may provoke a very grave collapse and even death if the animal is not promptly resuscitated.

We have said above (see par. 18, 19, and 20) that injection into the serous cavities and into the blood of the aqueous extracts of cholera viscera and of the urine passed after the algid period is without effect upon the animal experimented upon.

This inocuity makes it not very probable that the choleraic phenomena may be due to the general action of a poison.

The cholera bacilli grow in the intestine under the form of isolated comma bacilli or united two together; placed under favorable conditions for growth they may develop into a more perfect and more lengthened form—the cholera spirillum. Multiplication is brought about sometimes by the direct division of the comma, sometimes by the division of the spirilli into commas. Under certain special conditions spores are formed as well in the commas as in the spirilli, and these spores become free by the destruction of the bodies which are in the process of spore formation. These spores probably constitute the most resistant form of the cholera microbe, and this fact would explain the persistence of infection in localities where the disease is endemic.

In closing this report I must express here my thanks to the municipal authorities of Genoa, who, desiring to ask of science the solution of so grave a question of public hygiene, have generously placed all the means necessary for the research at the disposition of him who was charged with it.

The epidemic of 1884 at Genoa will certainly remain one of the most important pages of the history of cholera; breaking out suddenly in divers points of the city, it was promptly



extinguished by the energy of the mayor, Baron Podesta, who at once devoted himself to removing the most probable causes of the epidemic, and succeeded by the rigorous application of measures of disinfection wisely chosen.

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*RESEARCHES ON THE EVOLUTION OF THE COMMA BACILLUS OF CHOLERA.*

DOYEN (Progr. Med., 1885, No. 27, and Arch. de phys. norm. et path., t. vi, 1885), under Cornil's direction, confirmed in all important points the observations of Koch concerning the morphological, biological, and pathogenic qualities of the cholera bacillus, and criticised the publications of Emmerich and Ferrán. Doyen states that not only in the intestines but also in the kidney and liver of cholera corpses the Koch comma bacilli were found as well by the culture methods as by the microscopic examination of sections. He records the same result in the case of animals killed by inoculation of cholera, and considers that the specific cholera bacillus enters the circulation in man as in animals experimented upon. He affirms, therefore, the infection of the whole body by cholera, not through absorption of a soluble poisonous product of the cholera bacillus, but through the dissemination of the cholera bacilli themselves within the body. The author could not discover the presence of a poison in the gelatine cultures of Koch's comma bacillus; subcutaneous injection of such cultures produced no dangerous results. Especial interest attaches to the cholera experiments of this author, who inoculated 180 animals, mostly guinea-pigs, but also dogs, white rats, and rabbits. Whilst his early infection experiments had given only inconstant and doubtful results, when following the method of Nicati and Rietsch he obtained quite constant and typical results by the employment of Koch's method, as described in the second cholera conference. During the course of these experiments, however, he discovered that any of the alcoholic preparations of opium were effective, whilst, on the contrary, watery solutions of opium were not. Pure alcohol possessed the same effect as the tinctures of opium.\* Doyen, like Nicati and Rietsch, found that the virulence of the comma bacilli culture lessens with age and finally is lost. Microscopic examination of old cultures demonstrated the presence of round bodies, such as Ferrán called developmental forms, which he, like Koch, regards as products of involution.

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*ETIOLOGY OF CHOLERA.*

BABES (Virch. archiv. Bd. XCIX., 1885) confirms in all the essential particulars Koch's discovery of the comma bacillus as constantly and exclusively occurring in cholera. He states that it is only with gelatine of a certain strength (that is 10 per cent.) that the cholera bacillus grows as characteristically as represented by Koch, whilst with weaker gelatine deviations occur which make a confounding of the cholera bacillus with other bacteria possible. He states also that chemical alterations of the culture medium (as example, addition of corrosive sublimate to the gelatine in the proportion of 1 to 90,000), as well as a greater or lesser quantity of bacilli introduced into the medium causes variations in the character of the cultures. But not only the form of the culture, but even also the form of the cholera bacillus itself, according to Babes, may through modification of the constitution of the culture medium experience many smaller departures from the irregularity of type, and neglect of this fact may give rise to erroneous interpretations. Babes admits that whilst the cholera bacilli soon die in distilled water, but can live in rivers of running water for 7 days, and under certain circumstances perhaps longer, yet they are very sensitive to heat, being killed at 70° to 80° C. Concerning the effect of disinfectants upon the comma bacillus, this author is in entire accord with Koch. Babes also undertook a series of investigations upon animals concerning the infectious quality of comma bacillus and obtained positive results confirming the observations of Koch.

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\* This refers to the use by Koch of intra-peritoneal injections of tincture of opium as an essential preparation of the guinea-pig for ingestion of cholera microbe cultures. (See his method already described.)

*BACTERIOLOGICAL INVESTIGATIONS CONCERNING CHOLERA IN TURIN.*

SCHOTTELIUS (Deutsch. med. Wochr., 1885, No. 14) undertook in Turin in a number of cases the examination of cholera dejecta in all stages of the disease. The microscopic examination did not always succeed. Usually Koch's comma bacilli were found in cover glass preparations from the first characteristic evacuation; in two cases which ran a fatal course in a few hours from the beginning to the end of the disease the author failed to find them by microscopic examination; on the contrary, by means of plate cultures the comma bacilli were found to have been present without exception, even in those cases where the microscopic examination had failed. In order to lessen the difficulty of the microscopic examination, the author recommends the following method: A large quantity, about 100 to 200 grammes of the evacuated material, should be mixed with 250 to 500 cubic centimeters of alkaline beef broth (or with the Koch nutrient gelatine 10 times diluted), well shaken up, and placed for 10 to 12 hours in a warm place, or in the incubator (at a temperature of not more than 40° C.). The multiplied comma bacilli rise to the surface of the fluid, and it suffices to place a drop of this fluid upon the cover glass to obtain almost a pure culture of the comma bacillus. The author claims for this method greater rapidity than with the plate cultures. He also states that he has never found the Finkler-Prior bacillus in cholera dejecta, and never once found comma bacilli of any kind in diarrhoea stools.

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*BACTERIOLOGICAL INVESTIGATIONS OF SUSPECTED CASES OF CHOLERA UNDER DIFFICULT CONDITIONS.*

By MAX GRUBER.\*

During a suspected outbreak of cholera in Krain the intestinal contents were sent to Gruber to ascertain the presence or absence of cholera bacilli. The material reached him four or five days after death, and, the weather being very warm, was in a highly putrid state. It was therefore probable that by that time the cholera bacilli were mostly dead, and Gruber had to find methods which would yield positive results. In twenty-two specimens sent to him he found the cholera bacilli by direct plate cultures only in eight cases. He therefore at first employed the method recommended by Schottelius of adding a small quantity of the material to a vessel containing sterile meat infusion and placing this at 36° C. for 24 hours. According to Schottelius the cholera bacteria grow rapidly and form a layer at the surface; but Gruber did not find this plan satisfactory, and accordingly tried the method suggested by Buchner, by which one cultivates cholera bacilli for 7 days at 37° C. in a meat infusion containing 1 per cent. of peptone; this broth is then boiled and diluted with ten times its volume of 0.6 per cent. solution of common salt. A small quantity of the material supposed to contain cholera bacilli is then sown in this diluted infusion. The idea is that in this fluid a considerable amount of the products of the cholera bacilli are present and are more inimical to the growth of other bacteria than to that of cholera bacilli, and hence if the latter are present in the material under examination, even in small numbers, they will rapidly develop and form a thin layer at the surface. Gruber obtained better results with this method than with that of Schottelius, but he made a very important observation in connection with it. He found that when old material was added to this fluid the cholera bacilli in several instances did not appear till after the lapse of a number of days (in one case of 15 days). This is of great importance not only for the technique, but also for the mode in which these bacilli produce cholera, for Gruber considers that Pettinkoffer is correct in so far as he says that the cholera organisms must spread in the soil and that the epidemic only breaks out after this has occurred. But it was first supposed that in the struggle for life with other bacteria the cholera bacilli went to the wall, but the above observation shows that this is not always the case. Gruber is making further observation on the concurrent growth of these bacilli with other saprophytic

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\*Lond. Med. Rec., 4, 15, 1887.



bacteria, more especially with those present in the soil, and though these investigations are not yet ended they already show that the cholera bacilli hold their ground very well when grown along with those found in the soil if only plenty of oxygen is present.

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*BACTERIOLOGICAL INVESTIGATIONS CONCERNING ETIOLOGY OF CHOLERA.*

F. HUEPPE.\*

This author succeeded in making continuous microscopic observations of cover-glass cultures of the comma bacilli upon a heated stage at 34° to 37° C. He thereby proved that by progressive exhaustion of the culture material the comma bacilli became less active and as the temperature increased grew into spiral filaments, whose length varied from one and a half turns of the spiral to quite long threads more or less closely wound, sometimes forming loops and twisted filaments. At a certain point in the course of a single filament appeared two little bullet-shaped bodies, slightly larger in diameter than that of the filament, and having a greater index of refraction; then a second comma showed itself in this process of division. According to the rapidity of this process, there would be four bullet-shaped bodies rather widely separated from each other. The author directly followed this process as far as the formation of six bullet-shaped bodies in the course of a single filament. In the same place where he had previously observed the commencement of division he later found a still larger number of bullet-shaped bodies, and on either side of the collection also a short length of curved filament. The author followed this mode of production as far as the formation of zoöglea, which he observed at a point where previously he had seen a filament, as well as in positions where formerly single bullet-shaped bodies were to be seen upon and among the comma bacilli and the curved filaments. Once the author saw a motile comma, without previously growing into a thread, directly divide into two bullet-shaped bodies, after increase of movement and increase of refraction. The newly formed round bodies are motionless. They certainly do not multiply by division, but rather form new commas by budding. Three times has the author watched with the eye how a few of these round bodies extend out into a round rod whilst the refraction decreases, and in lengthening become curved into a comma and ultimately coiled into a short spiral. He was fortunate enough to observe once this mode of growth and process of budding in the same object. The above-described bullet-shaped members of the cholera spirilli are therefore to be regarded as spores (the author denominates them arthrospores). In cultures kept below 22° C. the author could not remark any appearance of such spore formation; but he does not assert that this temperature is its lowest limit. Besides this spore formation the author has noticed a degeneration of the spirilli into granules, which were neither spores nor cocci, but represented a phase of regressive metamorphoses, the so-called granules being devoid of any power of growth as far as the author has seen. According to him other species of curved bacilli also follow this same method of fructification. Furthermore, he regards the so-called comma bacilli as spirochæte, denying that they are either vibrones or spirilli. In some species of both of the latter families undoubted endogenous spore formation may be observed. Among the spirochæte should be classified such spiral bacteria as do not fructify by endogenous growth, but exclusively by member-spores (Glieder-sporen).

[The first to observe and describe spherical forms of various size in pure cultures of the comma bacillus, and attribute to them a fixed place in the cycle of development of the latter micro-organism, was Dr Jaime Ferrán, of Spain, whose observations at first met with decided adverse criticism from all quarters. Consult his communication on later pages of this report.—E. O. S.]

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\* Fortschr. d. Med. 1885, No. 19.

## PROGRESS IN THE KNOWLEDGE OF THE CAUSE OF ASIATIC CHOLERA.

F. HÜPPE.\*

Besides the already known differences which the Koch, Finkler-Prior, and Deneke spirochætae present with respect to artificial culture media, their behavior in milk furnishes a useful means of differentiation. Whilst, as Koch has affirmed, the cholera bacteria proliferate exuberantly in milk without visibly altering it, the Deneke, and still more markedly the Finkler-Prior, microbes, cause coagulation with subsequent tripsin-like peptonization of the caseine. Furthermore, there appears upon the surface of the cream an almost sulphur-yellow pigment in the milk cultures of the Deneke bacteria, which cultures of neither of the other comma bacilli forms ever show.

The infection experiments upon animals with cholera bacteria Hüppe has considerably advanced. He affirms, as the result of a few experiments, that only the living, but not the dead, cholera microbes possess a harmful power, and he brings forward these experiments as a contradiction to Cantani's opposite views.

Furthermore, he presents the proof that infection of guinea-pigs from the peritoneal cavity succeeds even with a minimal quantity of the pure culture. The cholera bacteria become localized in this mode of infection just as well as in the case of direct introduction into the intestinal canal, a fresh proof that alterations in the intestinal canal are not necessary for infection by that course, but that the small intestine as *locus minoris resistentiae* can be attacked secondarily by the cholera microbes. The entrance of the bacteria into the lumen of the intestine in Hüppe's experiments occurred very probably by a direct penetration through the intact intestinal wall. The impenetrability of the latter by bacteria affirmed by Wyssokowitsch on the ground of his well-known experiments cannot, after the experiments of Hüppe, as well as of others, be accepted as a universal law. The comma bacilli, once arrived in the lumen of the intestine, they act in the same manner as in the case of direct infection. Hüppe shows by experimentation that the cholera bacilli at first excite an inflammatory hyperæmia and an increased secretion; then they cause a partial necrosis of the epithelia, penetrate between these elements, and occasion by their rapid multiplication between the epithelia and the basement membrane upon which they rest the known destruction and desquamation of the epithelial layer. At this stage the secretions, as a rule, are altered; the exudate becomes a slimy fluid; these cholera bacilli can now multiply exuberantly in the intestinal canal. But the intestinal contents in the case of the guinea-pig only very seldom acquire a true rice-water or starch-enema-like quality. They usually continue to be slightly tinged with bile, but, on the contrary, often assume a decidedly bloody aspect, which is due to hemorrhages from the markedly œdemous membrane. Penetration of the specific bacteria into the connective tissue of the latter in these series of experiments did not take place, but they constantly reached the gall bladder however. Quite similar conditions Hüppe demonstrated by microscopical examination of the intestines of human cholera cadavers, which material was furnished him from Trieste.

## PATHOLOGICAL INVESTIGATIONS CONCERNING CHOLERA.

By ZÄSLEIN.†

This author, after an extensive investigation, has reached the following conclusions:

a.—Of the spores of the comma bacillus: The existence of the Hüppe's arthrospores was confirmed by him. They resisted drying for three hours and a half, whilst in the case of the simple bacillus the resistance is only from three to five minutes.

\*Ueber Fortschritte in der Kenntniss der Ursache der Cholera-Asiatica. (Berliner klinische Wochenschrift, 1887, Nro. 9-12, from Baumgarten's Jahresbericht, zweiter Jahrgang.

†Deut. Med. Zeit., 11, 28, 1887.



b.—Of the transformations of the comma bacillus: The comma bacilli obtained from the first cases of the epidemic retained its characteristics for a whole year, whilst those obtained from the last cases experienced modifications which the colonies constantly showed in their varying contents. In these last colonies very many round bodies were to be found which often attained a very unusual volume. These bodies Zäslein named “coccophores,” and they are probably the “mother spores” described by Schrön. From them are extruded the cocci, which give rise to the formation of straight and curved bacilli, which are much smaller than the comma bacilli of Koch. These cultures give no cholera-red reaction.

c.—Investigations in 30 cases of diarrhoea accompanying the last epidemic were made. In 25 of them bacilli were found which were very similar to those modified forms, not exactly like the Koch or the Finkler bacillus. During the first month the development in artificial cultures progressed very slowly, but later the development was more rapid. The bacilli then very much resembled those of Koch, but not perfectly. At the same time the gravity of the diarrhoea became greater without, however, assuming the character of Asiatic cholera. Only in 3 cases did the cultures yield the cholera-red color reaction.

Tizzoni remarked concerning Zäslein's observations that the bodies which he had found in the different organs, and which in cultures developed into the form of comma bacilli, were not “cocci,” but undescribed forms differing from the cocci, which, according to Zäslein, originated by modifications of the comma bacillus.

NICATI AND REITSCH (Berlin. klin. Wochenschr., 7, 1887) undertook new experiments bearing upon Hüppe's well-known claims concerning the discovery of the development of a resistant form of cholera bacteria. Without in the least doubting the reliability of Hüppe's observations, they believe that another interpretation should be placed upon them; they are inclined to regard the “arthrospores” of Hüppe simply as very short-lived cells.

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#### ON THE OBSERVATIONS OF FERRÁN. •

RAPTSCHIEWSKI.\*

This author undertook observations concerning those of Ferrán relative to the morphology of the comma bacillus of Koch. He examined cultures from two days to four months old. He declares that the multiplication of the bacillus occurs only by division, not by spore formation. The division proceeds in such a manner that in the middle of the bacillus a clear space forms which does not become stained by the fuchsin, and it is at this place that the division occurs. From two to six weeks old cultures give pictures which at first look like impurity of the cultures; besides the curved spirilli bullet-shaped bodies of different sizes are met with, from the smallest diameter up to the size of a red blood corpuscle, sometimes free, sometimes in the middle or at the end of a swollen portion of the spirilli. Occasionally in old cultures he noticed the appearance of a mulberry form. In cultures more than two months old only the bullet-shaped bodies, the mulberry forms, and detritus are found. In agar-agar and upon potatoes he could find nothing of the kind (contrary to van Ermengem). According to the author the mulberry-shaped body is formed from the bullet-shaped forms by fatty degenerations. There was no presence of spore formation in the spirilli; neither by aid of Buchner's method nor by that of Bienstock or Hüppe could the presence of spores be discovered. The result of his investigation is that the author confirms many of the statements of Ferrán concerning the existence of forms described by him, but he considers as erroneous the Spanish investigator's interpretation of these forms. He finds neither that endogenous spore formation occurs, nor that the bullet-shaped bodies play any rôle in the development of the comma bacillus. On the contrary, these bodies are only involution products.

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\* Wratsch, 1885, No. 29.

## THE CAMBRIDGE CHOLERA FUNGUS CRITICISED.

By E. KLEIN.\*

In No. 247, Vol. XLI of the Proceedings of the Royal Society, just published, there is a preliminary report on the pathology of cholera Asiatica, by Messrs. C. Roy, J. Graham Brown, and S. C. Sherrington, in which these gentlemen describe and figure the occurrence, in the tissue of the intestinal mucous membrane of persons dead of cholera Asiatica, of hyphæ or myceliæ, and "granules." Messrs. Vines and Gardiner, we are told, declare these to be chitridiaceæ. We are further informed that these chitridiaceæ were found by Messrs. Roy, Brown, and Sherrington in the intestinal mucous membrane of the 25 cases of cholera they have examined, as also in the kidneys and in the blood vessels of some of these cases. I have no hesitation in saying that I consider these statements as based on errors. What these gentlemen have seen and described is nothing less or more than the hyphæ or mycelial threads of common mold (probably *aspergillus*), which during preservation of the material have grown from the free surface into the tissues.

I possess a large number of specimens made of diseased intestines—lung, kidney, liver, and skin of various animals, and man—in no way connected with Asiatic cholera; in many of these I found the exact appearance described and figured by these gentlemen, viz. mycelial threads of precisely the same size and appearance as those above mentioned. They are seen to penetrate from the surface, where they form a copious, dense mycellium into the depths in various degrees. I possess sections from the mucous membrane of the intestine of a calf, of a mouse, of a guinea-pig, and of man in which these hyphæ have penetrated as deep as the submucous tissue. In the lymphatics of this part they were very abundant. Similarly I have specimens of the lung of a calf, a cow, and a guinea-pig, where the growth of the mycelial thread can be traced from the pleural surface into the lung tissue. In the lymph vessels of the interlobular septa they are very numerous and possessed of those knob-shaped outgrowths figured and described by Messrs. Roy, Brown, and Sherrington.

I have also specimens of the ulcerated skin of a calf and a cow where these hyphæ can be traced as deep as the subcutaneous tissue. Into the kidney and the mesenteric lymphatic glands they also penetrate, but less than in the above organs, probably owing to the greater tenacity of the tissue. Now, in all these instances these tissues have been preserved over the summer months; they were examined after three or more months' preservation, and the sections were stained in methyl-blue, and I must state also that the same tissues had been examined fresh and after a few weeks' hardening, and in none of them had any mycelial growths been present. It is a fact, as pointed out by Messrs. Roy, Brown, and Sherrington, that methyl-blue brings the threads out more easily and better than any other aniline dyes. There can be absolutely no doubt about the identity of the Cambridge chitridiaceæ with the hyphæ of the common mold found in the sections of non-choleraic specimens. What the Messrs. Roy, Brown, and Sherrington describe as "granules" connected by delicate filaments are in most instances filaments and branches seen in optical or real transverse section. With careful, fine adjustment of the microscope this can be without difficulty ascertained. Messrs. Roy, Brown, and Sherrington assume that their "chitridiaceæ" have been overlooked by others who have examined cholera intestines because methyl-blue has not been used. This assumption is entirely wrong, because methylene blue, as Loeffler's (alkaline) solution, and in other modifications, had been used by many investigators. While in India I largely used it for staining sections, fresh and after a few weeks' hardening, and I know as a positive fact that the German commission have in Egypt and India and after their return to Berlin largely used this dye; but in not one single case have they or have I found anything of mycelial threads either in the intestinal mucous membrane or in any other organ. The only difference between Messrs. Roy, Brown, and Sherrington on the one hand and all the other investigators on the other is this, that while the former kept their material bottled over the summer (vide their report, p. 177) the latter examined theirs fresh or after short and careful hardening.

\* British Medical Journal, December 25, 1886.



That this is the real explanation of the difference of our results is proved by the following: A bottle containing bits of cholera intestine preserved by me in Calcutta and brought over to England was opened many months after; sections were made of the intestine and stained in methylene blue. On the free surface of the mucous membrane was found a dense plexus of mycelial threads of common mold from which threads of various thickness had singly grown into the tissue to the depth of the submucous tissue:

Of the same choleraic intestine numerous sections had been made in Calcutta fresh and after a few days' hardening; these had been stained in methyl-blue,\* but in none of them is there any trace of mycelial threads. I have these sections at present in my possession, and while they show that there is a complete absence in the mucous membrane of mycelial threads, the others, viz, those made of the same intestine and after the same method, but after having been kept bottled for some months, showed beautiful mycelial threads pervading the mucous membrane through all depths. These threads in their course, thickness, mode of branching, in the character of their bud-like sprouts—in short, in all their morphological characters—are unmistakably identical with the hyphæ found in specimens of the non-choleraic intestine, lung, skin, and kidney.

In conclusion, I wish to say that I shall be most happy to place at the disposal of Messrs. Roy, Brown, and Sherrington, as also of Mr. Vines and Gardiner, the materials or sections, mounted and stained, of the various non-choleraic tissues, in which are presented the mycelial threads of common mold, identical with the Cambridge cholera fungus.

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*OBSERVATIONS ON ASIATIC CHOLERA IN ITALY, 1886.*

By CHARLES S. SHERRINGTON.\*

The following is abstracted from the communication of Mr. Sherrington, one of the members of the Cambridge Commission to investigate cholera in Spain during 1885, in which the erroneous conclusions of that commission are admitted as demonstrated:

“Last summer, when cholera again appeared in Italy, I determined to seize the opportunity that seemed to offer itself for re-examining the disease, especially with regard to some questions raised by the work of the previous year.” \* \* \* “The matter collected consists in all of specimens and preparations made from 25 fatal cases. Of these 22 were indubitable examples of rapidly fatal cholera Asiatica. These were obtained exclusively out of the Province of Puglia. The remaining 3 cases were from Venezia, and were, in the opinion of myself and Dr. Rouse, who in Venezia assisted me, not examples of true cholera.” \* \* \* “In this year's work I have completely failed after minute, long, and repeated search, with the use of good lenses (new apochromatic system of Zeiss), and after employment of various methods of staining, including that by which the Spanish preparations were colored, to find any trace of the above-mentioned appearances (*i. e.* those reported by Professor Roy and his associates as found in Spain in 1885) in any of the material obtained in Italy. Neither in the specimens of the tissues nor of the intestinal fluid post-mortem, nor of the vomit or dejecta during life, is any trace of them to be found. Any view that suggested itself of a causal connection of them with cholera must therefore meet the difficulty that they form no constant anatomical feature of the disease.” \* \* \*

“With regard to the presence of comma bacilli in my material, such forms have been found in altogether 13 of the cases from Puglia, although always with difficulty, and seven times only after extremely patient and rigorous search.” \* \* \*

“Having only the morphological characters of the bacilli for criterion, I have compared them always with specimens from pure cultivations of Koch's comma bacilli freshly prepared for the purpose, and I have only accepted them as such when they have agreed with the latter standard form.”

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\* Communicated by M. Foster, secretary to the Royal Society of London.—Proceedings of the Royal Society of London, 1887.

"Of the cases in which the comma bacilli have been found, in three they may be called 'fairly numerous;' in five, 'sparse,' and in five, 'very scanty.' The bacilli have never been found in any other situation than in the wall of the alimentary canal and in the wall only in the most superficial portion of the tissue, in the mucosa." \* \* \* "The comma bacilli lie in the fundi of the tubular glands of especially the ileum and in the tissue in which those glands are embedded in the immediate vicinity of the glands. Their distribution is not uniform but patchy. They occur with various other forms of bacteria in the same situation. Generally of these other forms some have penetrated more deeply into the tissue than have the comma bacilli; especially is this true of certain fine, straight bacilli resembling morphologically the bacterium coli commune of Escherich.

"Of those cases in which comma bacilli have not been found the impression left upon me is that in some of them it is possible that still further examination of a still more extended series of preparations from them might have revealed comma bacilli in the wall of the intestine in some of them. They are all cases that, although of rapidly fatal issue, had passed into a stage of febrile reaction."

All of the above remarks relate to the examination of sections of the intestinal wall.

"With regard to the preparations made from freshly evacuated dejecta and vomit from living cases the six cases examined reveal comma bacilli in the stools in five. There is no evidence of blood in these five stools, but blood is mixed with the intestinal fluid in the case in which no comma bacilli are seen. The vomit also in three of the cases shows a small number of comma bacilli. In none of the preparations do the comma bacilli make up more than a small fraction of all the bacterial forms present."

[It is to be remarked that the observations of Mr. Sherrington were morphological solely. Culture methods were not resorted to. Hence negative results of observations relating to numbers of the comma bacillus of Koch can have but little value.]

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#### THE CHEESE BACILLUS OF DENEKE.

TH. DENEKE (Deuts. med. Wochr., 1885, No. 3) describes a new organism very similar morphologically to the cholera bacillus of Koch, which he accidentally found upon old cheese. The author found by cultivation a difference between this new organism and that of genuine cholera, as also that of Finkler and Prior. According to him the comma bacillus very slowly renders nutrient gelatine fluid, the Deneke bacillus more rapidly, and Finkler and Prior still more energetically. The Deneke bacillus does not grow upon potato, while the Finkler and Prior bacillus grows upon it luxuriantly at low temperatures; the Koch bacillus only grows upon it naturally at high temperature and then slowly. The experiments upon animals show striking differences. Whilst the Koch comma bacillus after infection through the stomach into the intestinal canal causes the death of the animal, it is noticeable that the Deneke, and the Finkler and Prior bacillus, even when administered in large numbers, produces much less reaction in the intestines.

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#### A COMMA BACILLUS IN THE HUMAN MOUTH.

By Prof. Dr. W. D. MILLER, *Berlin*.\*

Miller (Deutsch. med. Wochr., 1885, No. 9) has demonstrated the presence of a comma bacillus, which he has isolated by pure culture from a carious tooth not identical with the common curved bacillus of the cavity of the mouth, which Miller had long before previously described and drawn, and which Lewis had regarded as altogether identical with the comma bacillus of Koch. This common curved bacillus of the mouth does not grow in 10 per cent. gelatine, whilst Miller, as above mentioned, has readily cultivated pure his bacillus from a

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\*Demonstrated February 16, 1885, at the Verein Für Innere Medicin.



human carious tooth. Although the form and size of the new Miller bacillus make it very similar to Koch's cholera bacillus, it is distinguished from the latter by its unusually rapid growth in gelatine—thus the more closely resembling the Finkler and Prior bacillus, by its rapidity of growth and by the appearance of the plate and tube cultures in gelatine. Miller, however, leaves the question of its identity with that of Finkler and Prior still open.

It is a well-known fact that (Verein f. innere Med. loc. cit.) comma-shaped bacilli are constantly present in the human mouth, even in a state of perfect health. No particular importance was, however, attached to this fact until these bacilli were by Professor Lewis asserted to be identical with Koch's comma bacilli of cholera Asiatica. Since that time very many bacteriologists have constantly endeavored to obtain the comma bacilli of the mouth in pure culture. In the *Deutsch Medicinische Wochenschrift*, 1884, I described two different schizomycetes which I had isolated from the oral secretions, and which in certain cases appeared as distinctly curved bacteria.

Not until within a few days, however, did I succeed in isolating from the mouth a true comma bacillus, and it was finally accomplished in two cases by the use of coagulated beef blood serum. The material from which the cultures were made was in each case found under the margin of inflamed gums in unhealthy mouths. Morphologically this bacillus is very similar to the other well-known comma bacillus, occurring as commas, either singly or in twos or in spirillum form. In old cultures of gelatine all the commas sometimes develop into spirilli, presenting a pure spirillum culture, cultivated on plates of beef-peptonegelatine at 20°C. They appear after 20 hours (in the second dilution) under a power of 100 diameters as perfectly round, finely granular colonies, with a smooth border and brown color; in the same time the first dilution will be completely liquefied. They liquefy coagulated blood serum with great energy, as do the other comma bacilli. On the surface of agar-agar they form a yellowish coating, and convert the medium superficially only into a paste. They grow slowly on boiled potato. I have consequently not yet been able to establish any definite peculiarity of growth. The reactions of this bacillus are such as at once establish the fact that it is altogether a different organism from the comma bacillus of Koch. It possesses, on the other hand, many of the peculiarities of the Finkler-Prior bacillus. Whether it is identical with this organism must be established by further experiment.

It must be remarked that this organism is in all probability not the one which is constantly to be found in every mouth. The former grows rapidly on 10 per cent. gelatine, while the latter appears to be unable to grow at all on the same medium.

Dr. Klein, in his report on cholera Asiatica (*British Medical Journal*, February 7, 1885), states that the comma bacilli of the human mouth have the same peculiarities of growth on gelatine as the comma bacilli of Koch, but not one of the many forms of micro-organisms, curved or otherwise, which I have obtained in pure culture from the human mouth is for a moment to be mistaken for the bacillus of Koch. If Dr. Klein has really succeeded in proving by culture methods that the common comma bacilli (vibriones) of the human mouth have the same reaction on gelatine as Koch's comma bacillus, then it is very desirable that we should be told how he did it, it being the testimony of a very large number of bacteriologists that these organisms do not grow at all on gelatine. An exact proof that the vibriones of the mouth have on various culture media the same reaction as Koch's bacillus would be a point of great weight, while a simple morphological similarity is of scarcely any importance whatever.

In medical journals, particularly the English, we continually meet with such statements as "Comma bacilli may be found in the human mouth;" "in the intestines in various disorders;" "in certain articles of diet," etc. It is assumed, therefore, that Koch's theory of the cause of cholera Asiatica is entirely wrong. It is surprising that such views should ever be published by any journal. What if comma bacilli are found in the human mouth? It is the testimony of ninety-nine out of one hundred that they are not the comma bacilli of Koch. What if they may be found in stale cheese? The cheese spirilli have been proved to be altogether a different organism from Koch's bacillus. It matters not where comma bacilli are found or in how great numbers, the question to be decided is whether any of these comma

bacilli are identical with Koch's, and the universal verdict is that they are not. It remains to be seen whether Dr. Klein can prove his statement as to the identity of the common mouth vibriones with the cholera bacillus.

To put down all comma-shaped micro-organisms as one and the same simply because they are curved is no more reasonable than it would be to treat all bacilli in the same manner because they are straight, and to affirm that a particular bacillus can not be the cause of tuberculosis because bacilli are found in the human mouth, in the intestines, and in various articles of food.

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KNOWLEDGE OF THE PARASITIC DISEASES OF THE MOUTH AND TEETH.

BY PROF. W. D. MILLER, *Berlin*,\*

This author has during the last few years published numerous researches concerning the various harmless and pathogenic or ferment producing bacteria to be found in the human mouth, stomach, and intestines. In the present communication the following remarks have some bearing upon the comma bacillus of cholera, and they are deemed worthy of introduction here:

"The attempt to discover the pathogenic microbes in diseases of the mouth and teeth is, on account of the great number of the bacteria of the mouth, exceedingly difficult if not impossible. The author has thus far investigated 50 different varieties. Of the mouth bacteria, which have up to the present proved to be uncultivable and of greater interest, may be mentioned *Leptothrix buccalis* (for a long time regarded as the cause of caries of the teeth), *vibrio buccalis* (falsely announced three years ago by Lewis as identical with the cholera bacillus), and *spirochaete dentium*.

"Of the cultivatable bacteria we mention: (1) The bacillus found by the author in chronic inflammation of the dental pulp 'very similar or quite identical to the Finkler-Prior bacillus (of *cholera nostras*).'"

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BACTERIA OF THE AIR RESEMBLING COMMA BACILLI.

CORNIL AND BABES (*Les bactéries et leur rôle dans l'anatomie et l'histologie pathologiques des maladies infectieuses*, Deuxième édition, Paris, 1886) thus describe the following species of bacilli met with in the air, which, either by their morphology or peculiarities of growth in cultures, more or less resemble cholera bacilli but are not identical with the latter:

(a) The colonies by their form resemble those of cholera and slightly liquefy the gelatine but they are white and not yellowish, as those of cholera; they contain comma bacilli larger and shorter than those of cholera.

(b) The colonies grow in smooth white patches, slightly transparent, of an irregular contour; the bacilli are short, rounded at the extremities, sometimes a little curved, sometimes joined together in short wavy filaments.

(j) The colonies liquefy the gelatine, the yellowish central portion is surrounded by a regular reticulum, leaving rounded spaces between its meshes; they are composed of fine rods long and slightly curved.

These authors also describe the following varieties of bacteria as met with in the normal stools; they have more less resemblance either biologically or morphologically to the comma bacillus of Koch, but are not identical with it: -

One of them (Babes) has cultivated the following baccilli obtained from the normal intestinal mucus:

(a) The gray colonies liquefy the gelatine. In the middle of the liquefied portion is found the colony with a regular outline; the liquefied portion is surrounded by sinuous rays;

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\* *Centralblatt f. Bact.*, Bd. 1, 1887.



the colony consists of curved bacilli a little larger than those of cholera itself; the cultures in gelatine tubes resemble slightly those of cholera, except that the air-bubble is very long and the liquified portion of the puncture reaches as far as the bottom of the tube.

(b) The colonies in gelatine plate cultures resemble those of cholera, but they do not liquefy the gelatine; the bacilli are also curved and similar in this respect to those of cholera.

(c) Oval dark yellowish colonies having a striated double contour do not liquefy the gelatine, and are composed of curved bacilli in the shape of a comma much thicker than that of cholera.

(d) The colonies liquefy the gelatine; in the middle of the liquefied portion the colonies are observed under the form of a trellis, slightly yellowish, the trabeculae of which are separated by openings; by their form the bacilli recall those of cholera, but they are thicker, more rarely curved, and their extremities are truncated.

(e) The colonies of a dark brownish yellow color, formed by sinuous fringes, pretty quickly liquefy the gelatine, and have a rapid growth; they are composed of very fine little bacilli, slightly curved, which present dark granules at their extremities. These colonies are obtained from the intestine of the guinea-pig.

#### A COMMA BACILLUS IN CHOLERA NOSTRAS.

By FINKLER AND PRIOR.

After a long and painstaking research upon the cholera bacteria Professor Finkler and Dr. Prior published at the end of their communication (Centralblatt f. allgemeine Gesundheitspflege, erster Band, Bonn, 1885) the following resumé:

(1) We confirm the presence of Koch's comma bacillus in the intestinal contents and in the dejecta of cholera Asiatica in the epidemic of Genoa, 1884.

(2) We have discovered comma bacilli in the dejecta of *cholera nostras* patients; we have found them as well by direct microscopic examination of the intestinal contents, as also by making pure cultures of them and we have described their characteristics.

(3) Both of these species of comma bacilli are vibriones, which grow into genuine spirilli. As well in morphology as in the changes of form which they undergo are these vibriones similar.

(4) The behavior under culture is identical in the case of both vibriones, the differences of circumstances affecting the nutrient medium and of temperature separate them very slightly from each other—differences which are to be explained as relative rather than absolute, such as greater energy of growth and vitality of the vibrio of *cholera nostras*.

(5) Of the physiological characters of the vibriones we especially emphasize the considerable power of resistance against drying, against different temperatures, and against decomposition.

(6) We affirm the possibility of a resting state and hold it as probable that it may be due to the formation of spores similar to those of other micro-organisms.

(7) Both vibriones are pathogenic.

(8) The pathogenic power of the vibrio of Koch is greater than that of the vibrio of Finkler-Prior; we have here also to do with only a relative difference.

(9) The pathogenic power is not shown in all species of animals; moreover a large number of them possess an immunity for both vibriones; they are distinguished only under certain circumstances. The receptive animal species and those which furnish favorable conditions are the same for both vibriones.

(10) The symptoms of disease which the two vibriones occasion in the animal body have a certain similarity with those of cholera in man; they are, however, not pathognomonic, but can in guinea-pigs be produced also by other infectious substances and chemical poisons.

(11) The etiological relation between the comma bacillus and Asiatic cholera is most probably established through its constant presence, but it is not proven with certainty by the

experiments upon animals. The etiological relation between the comma bacillus discovered by us and *cholera nostras* is established probably on the one hand by the presence of the micro-organism, on the other hand by the extensive correspondence as well in the appearances of *cholera nostras* and Asiatica as in the biological and pathological qualities of both comma bacilli.

(12) Both vibriones can be found in the blood after injection into the intestine and be excreted in the urine. The sojourn of the Koch vibrio in the animal body may increase the power of growth, so that thereby still another correspondence in the culture behavior of the two vibriones may be attained.

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#### ABSENCE OF THE FINKLER BACILLUS IN CHOLERA NOSTRAS.

MEYERHOEFER (Deutsch. med. Wochr., 1885, No. 46) obtained an autopsy of a typical case of *cholera nostras*. The light grayish perfectly fluid contents of intestines presented almost a pure culture of a small straight bacillus; no bacteria of curved form were discovered. In plate cultures numberless circular colonies grew in 24 hours from the intestinal fluid, which under low magnifying power presented a light brown aspect with a coarsely granular surface and a sharp border. They rapidly rendered the gelatine fluid, exhaling a penetrating odor. In tube cultures the colonies grew in the line of the puncture by the needle producing a translucent fluidity within 24 hours, and after a few days the whole of the gelatine became fluid, and there was a flocculent sediment of a cheesy appearance. Cover-glass cultures from the plate-culture colonies showed the development of actively moving bacteria without the formation of spirilli of any sort. These cover-glass cultures after staining showed the same bacillus, previously discovered, in absolutely pure culture. It is certain from this description that the above bacillus is not identical with the Finkler-Prior bacillus. As is well known, Koch has been unable to find the Finkler-Prior bacilli in the intestinal contents even in fatal cases of *cholera nostras*. The etiological relation of the Finkler-Prior bacillus with *cholera nostras* is therefore very questionable.

Dr. KARTULIS, of Alexandria (Zeitschrift für Hygiene, VI, Bd. I, Heft, 1889), in writing upon the etiology of *cholera nostras* in contrast to choleriform diseases, mentions a similar investigation by Frank, who reported the bacteriological investigation of the intestinal contents of 11 cases, of which 7 were *cholera nostras*, 2 arsenical poisoning, and 2 peritonitis. He also cites his own, 12 suspicious cases. Of these, only 2 corresponded closely with cholera in their symptoms; the other 10 included arsenical poisoning, copper poisoning, and sausage poisoning. The object of these investigations was the determination of the presence or absence of curved bacilli with special intention of comparing their morphological and biological qualities with those of the comma bacillus of Koch and of the Finkler and Prior bacillus. The result of the investigations of Dr. Kartulis was entirely negative; no curved bacilli of any kind were found in any of these cases.

BIEDERT (Der neueste Stand der Cholera-Frage, Deut. med. Zeitung, 1885, No. 81, from Baumgarten's Jahresbericht, zweiter Jahrgang):

This author sought for comma bacilli in the stools and intestinal contents of a fatal case of suspected cholera by the use of Koch's methods, but found neither the Koch nor the Finkler-Prior spirilli. The case was therefore freed from the suspicion of cholera Asiatica and regarded as *cholera nostras* (arsenical poisoning was excluded by chemical analysis).

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#### THE NAPLES CHOLERA BACILLUS.

EMMERICH (Arch. f. Hygiene, 1885) in Naples had the opportunity to conduct investigations upon 9 cases of Asiatic cholera. The object of his journey to Italy, under the authority of the Hygienic Institute of Munich, was to obtain pure cultures of the comma bacillus of



Koch. He occupied his time in the examination of the whole intestinal tract and in researches upon the blood and internal organs, neglecting to make use of plate cultures. Intending to resort to these later, he obtained pieces of the organs and specimens of blood from all of the cholera corpses and of the blood of cholera patients, and placed them in test-tubes of sterilized gelatine, which he brought back to Munich. Emmerich often found the comma bacillus of Koch in the intestinal contents of these cases, as well as of other cases of cholera, although not during the whole duration of the disease. But he positively affirmed, besides the comma bacilli of Koch, the presence of other comma-like bacteria, and furthermore asserted that there were cholera cases in which neither the comma bacilli of Koch, nor other comma bacilli could be recognized either by microscopic examination or by the plate-culture method. Emmerich, however, never missed in the intestinal contents of cholera and other kinds of cholera a bacterium, in the shape of a short rod, which he regarded as closely allied both morphologically and biologically to the pathogenic typhus bacillus, distinguishable from it, however, as well as from all other known bacteria, as Buchner has declared. This "Naples bacillus," which is not only constantly but always even in enormous numbers present in the cholera dejecta, also is found to be growing in all of the above-mentioned gelatine tubes containing the blood and organs of cholera cases almost throughout the whole series and in absolutely pure cultures, as was proven at Munich by resorting to plate cultures. With "the Naples" bacillus Emmerich performed a large series of inoculations, experiments upon guinea-pigs, rabbits, dogs, cats, and monkeys with the most positive results, which to him appeared to show that by sub-cutaneous, intra-abdominal and intra-pulmonal injection of the "Naples bacilli" a series of clinical symptoms, similar to those of cholera in man, as also of similar pathological appearances, were produced in all of the above-mentioned animals.

From his results thus obtained Emmerich held it as proven that the "Naples bacillus" discovered by him is the cause of Asiatic cholera, and that the Koch comma bacillus has only an accidental presence in the cholera dejecta. Although these experiments may not warrant Emmerich's opinion concerning the ethological relation between his bacillus and the production of genuine cholera, they seem to show that there may be several kinds of bacteria capable of exciting in animals a process very similar to cholera; thus Koch mentions that he has been able to produce upon guinea-pigs the above-described symptoms in a very characteristic way by the use of a species of pathogenic bacteria isolated by Brieger from human fæces. Virchow states that "in a large series of experiments concerning infection by means of the injection of septic substances into the blood, performed in the year 1847, he was able to produce appearance perfectly similar to cholera."

ESCHERICH (Fortschr. d. Med., 1885, Nos. 16 and 17) publishes the observation that he could by the use of both of his two very common fæces bacteria (milchkothbacterien), namely "bacterium coli comune" and "bacterium lactis ærogenes," produce symptoms of disease in guinea-pigs which could scarcely be distinguished from those of the Emmerich cholera in these animals.

BUCHNER (Arch. f. Hygiene, 1885), after an extraordinary and painstaking comparative bacteriological research concerning not only the normal, but also the abnormal, morphological and biological appearances of bacteria, as also those variations in growth seen by the naked eye and under the microscope, which chemical changes of the nutrient medium and transplantations from artificial-culture media to the living animal may produce in bacteria, and concerning further their chemical qualities (acid productions, fermentation, etc.), as well as, finally, their power of resistance to increase of harmful chemical agents (acid, alkali, etc.), cold and drying, arrives at the conclusion that the "Naples cholera bacilli" represent a species distinguishable from all other known bacteria. The author, in accordance with the views of von Emmerich, declares that this bacillus has a special significance in the small intestines. In spite of this, however, Buchner looks upon the question of the etiology of cholera as undecided by von Emmerich's experiments, and he regards the production of cholera epidemics from the same stand-point as Pettenkofer.

BUCHNER AND EMMERICH (Aerztl. Intelligenz-Blatt, Münchener med. Wochenschr., 1885, No. 44) after a new and comprehensive series of experiments, report (contrary to the experience of von Emmerich in the previous year) that no bacteria are to be found in the internal organs (liver, spleen, and heart blood) in the majority of acute cases of cholera. On the other hand, they found the "Naples cholera bacillus" in the bronchial mucus and in the lung tissue of corpses in several cases and, by means of the Koch plate-cultures they often discovered them among many thousand colonies pure or mixed with other bacteria. They believe that these observations confirm and give support to the theory that the lungs are the place of entrance of the germs of cholera. As a result of their investigations of the intestinal contents in cholera, the authors admit that the flakes of epithelium usually contain the Koch comma bacilli; but they assert also that the "Naples bacilli" are found in incomparably greater numbers in the fluid contents of the stomach and small intestines, often, indeed, in pure culture.

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ON THE COMMA BACILLUS OF KOCH AND THE BACILLUS OF EMMERICH.

COMPARATIVE EXPERIMENTS PERFORMED IN THE CHEMICAL LABORATORY OF THE UNIVERSITY OF PALERMO, NOVEMBER, 1885.

By Dr. F. COPPOLA.\*

According to the investigations of Dr. Emmerich upon cholera, commenced in Naples during the epidemic of 1884, and continued in Palermo in that of 1885, a new bacillus other than that of Koch's should be considered as the cause of cholera.

Unwilling to admit that the concurrence of two different bacilli may be necessary to cause a single disease, science should first of all determine whether the bacillus of Koch or that of Dr. Emmerich should be accepted as the true pathogenic agent of cholera, disregarding for the moment the possibility that neither one nor the other is the real cause.

This question looked at from the bacteriological point of view comprehends the morphology and biology of the choleraic agent; from the stand-point of pathology it comprises the nature of that disease. Whilst the bacillus of Koch is met with in the alimentary canal, that of Emmerich is found in the blood and in the internal organs; whilst in the first case cholera may be an infection localized in the intestinal canal, in the second case it should be considered as a general infection.

Leaving aside the discussion as to whether the clinical and epidemiological characters of cholera accord more with the first or with the second theory, and whether recent researches made in the field of bacteriology may be more favorable to the bacillus of Koch or to that of Emmerich, I limit myself to stating how the experiments made upon animals have not even to-day cleared up this question. Although Nicati and Rietsch, Babes, Flügge, Watson-Cheyne, as also Koch, Gibier, and Van Ermengen, affirm that they have produced Asiatic cholera with the comma bacillus, Dr. Emmerich asserts the same for the Naples bacillus.

This being the state of the question, I have thought it useful to compare the effects which each of these two bacilli produce in animals, although with the comma bacilli the inoculations have been made solely in the intestinal canal, and that of Emmerich solely beneath the skin; moreover, no one heretofore has had the opportunity to make comparative experiments with these two bacilli.

I have experimented upon guinea-pigs, using as material for inoculation perfectly pure cultures, sometimes of the bacillus of Koch obtained from the dejecta, sometimes of the bacillus of Emmerich with which Emmerich himself had the kindness to furnish me from a pure culture obtained in Palermo from the lungs of a cholera corpse.

With the comma bacillus, as with the bacillus of Emmerich, I have made two series of experiments. In the one I have performed the inoculations by way of the stomach after the method of Dr. Koch, which consists in introducing into the stomach by means of a catheter a 5 per cent. solution of carbonate of soda, and 20 to 30 minutes after some fluid from a culture

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\* Arch. p. le sci. med., vol. IX, n. 23.



of the comma bacillus, injecting immediately afterwards into the abdominal cavity a gramme of the alcoholic tincture of opium for every 200 grammes of weight of the animal; in the other series of experiments I have performed the inoculations hypodermically, by means of a syringe previously sterilized at  $150^{\circ}\text{C}$ ., first washing the site of injection with a solution of 1 to 500 of corrosive sublimate.

#### A.—EXPERIMENTS WITH THE COMMA BACILLUS.

(1) *Inoculations by way of the stomach*.—By this process I have performed six experiments, which uniformly succeeded. The weight of the guinea-pigs varied from 550 to 750 grammes; there was injected into the stomach from 3 to 4 cubic centimeters of the culture bouillon.

After 5 to 10 minutes from the operation, the animals fell into a narcotism more or less profound, from which after 60 to 90 minutes they began reviving. Not recovering their natural activity, but refusing food, they often laid down, and again, after making a few uncertain steps, resumed a recumbent position. Little by little they always became more prostrated. They dragged upon the floor the posterior extremities, which began to be paretic and more or less cold.

The rectal temperature from  $39\frac{5}{16}^{\circ}$ , which is the normal, fell step by step until it reached a minimum of  $35^{\circ}$ . There were evacuations, but not more frequent or less consistent than ordinary; the urine was suppressed almost always; sometimes lachrymation was observed. Reflex actions were preserved.

The respiration, which in the first period is most agitated, approaching suffocation, subsequently becomes slower and more shallow. The cardiac impulse always became weaker to the point of not being perceptible at all. With these symptoms, after 24 to 48 hours death invariably followed.

At the autopsy the lungs were found normal, the heart arrested in diastole, and even immediately after death not sensitive to the electric current. The stomach, the duodenum, and the whole small intestine as far as the cæcum was markedly injected and here and there were seen sparsely scattered points of ecchymosis. The cæcum and a large part of the colon were dilated but not injected. There was serum in the abdominal cavity. Incizing the walls of the stomach, a large quantity of fluid contents of a greenish color with ingested vegetables escaped; on the other hand, from the duodenum and the small intestine a large quantity of grayish and slightly gelatinous fluid with flakes suspended in it escaped; the cæcum and a good part of the colon contained much fluid mixed with fecal matter; finally, in the lower part of the colon and in the rectum solid well-formed fæces were met with. The mucous membrane of the stomach, of the duodenum, and of the small intestine showed much injection.

By means of gelatine plate-cultures I constantly found the stomach and various sections of the intestine, principally the small intestine, abundant in comma bacilli, almost in the condition of pure cultures. I never recovered comma bacilli or other vegetable organisms either from the lungs or the blood or the liver or the spleen, etc. In some experiments the procedure followed was that of introducing into the gelatine, by means of a platinum wire sterilized by heat, a small portion of the organ, which was removed with an instrument also previously sterilized by heat.

(2) *Hypodermic inoculations*.—By this process I have performed three experiments, which were not more extended because they gave constant results. I injected beneath the skin of the back one-half of a cubic centimeter of the comma bacillus culture.

Death occurred always within 12 to 24 hours. The cardiac impulse always became weak; the respiration more superficial. The animal seemed not so much prostrated in strength as it suffered; it cried spontaneously and when disturbed; it did not eat and it passed urine a few times; the evacuations were less frequent than ordinarily.

The extremities, first the posterior and then the anterior, became more and more cold; the rectal temperature gradually fell, in one case from  $39\frac{4}{16}^{\circ}$ , the point it was before the injection,

in an hour and a half as low as  $38\frac{2}{10}^{\circ}$ ; in  $2\frac{1}{2}$  hours to  $36\frac{8}{10}^{\circ}$ ; in 6 hours to  $34^{\circ}$ ; and in 12 hours to  $31^{\circ}$ . At the autopsy the lungs were hyperæmic and the heart flaccid; the fluid of the peritoneal cavity, the stomach, and the intestines were normal, or at most the duodenum was only slightly rosy. The stomach, the cæcum, and a large part of the small intestine contained solid matter; the duodenum and the portion adjacent to the ileum contained coagulated mucus.

Gelatine cultures demonstrated the presence of the comma bacillus in the intestinal canal and in all the organs, most abundantly in the spleen; but I never recovered them from the blood.

#### B.—EXPERIMENTS WITH THE EMMERICH BACILLUS.

(1) *Inoculations by way of the stomach.*—By this procedure I performed five experiments with only one followed by death. In order to compensate for the lesser activity of growth which the bacillus of Emmerich possesses in comparison to that of Koch, I always injected not less than 8 to 10 cubic centimeters of the bouillon. The effects of the opium having disappeared, the animal again began to eat after 3 to 4 hours without showing any symptom worthy of note; for 4 to 6 hours the rectal temperature remained lower than normal, but after 12 to 15 hours everything seemed to have entirely recovered its physiological condition.

In the case followed by death the animal was a guinea-pig far advanced in pregnancy. During the first 24 hours it did not present any special symptoms, but after 35 hours from the injection it gave birth to a dead fetus; after that it grew constantly worse until, without presenting any characteristic symptoms, it died 12 hours later.

At the autopsy the heart was found flaccid, the lungs congested, the stomach normal, containing solid matter, the duodenum and a greater part of the ileum hyperæmic, containing threads and flakes of mucus. The rest of the intestinal canal presented nothing abnormal.

Gelatine cultures were made, and by them the presence of the bacillus of Emmerich in pure culture was shown in the placenta and in the lungs of the fetus, the only organs which were examined. The same bacillus was abundant in the blood, in the lungs, in the liver, etc., and in the intestines of the mother.

(2) *Hypodermic inoculations*—By this method I have performed 5 experiments, all followed by death. A fact worthy of note is that after the injection a sensible increase of the body temperature was observed, which lasted from 5 to 7 hours. In one case, for example, the temperature measured in the rectum  $39\frac{2}{10}^{\circ}$  before the injection; after an hour and a half it was raised to  $40\frac{9}{10}^{\circ}$ ; after 3 hours to  $41\frac{4}{10}^{\circ}$ ; after 6 hours to  $39\frac{4}{10}^{\circ}$ .

At the same time a certain general hyper-excitability was observed; it respired more frequently; the cardiac impulse was stronger; the animal refused its food, passed urine and solid fæces. Sometimes movements were observed resembling efforts at vomiting.

After that the temperature began to fall to the normal; in one case two hours before death the temperature of the rectum was  $34\frac{2}{10}^{\circ}$ , whilst a few hours after death it measured  $25^{\circ}$ . The respiration became less frequent and more shallow; the cardiac impulse became imperceptible; first the posterior extremities then the anterior became paretic, but reflexes were preserved in a normal condition to the last. Without any new symptoms after 12 to 30 hours death supervened.

At the autopsy the lungs were found hyperæmic, the heart flaccid, the stomach normal or slightly injected, but always distended with solid food; the duodenum and the greater part of the small intestines were injected and contained flakes and threads of mucus. The rest of the intestinal canal was normal and filled with solid matter.

Gelatine cultures showed that the blood, the lungs, the liver, the kidneys, the duodenum, etc., contained pure cultures of the bacillus of Emmerich.

#### CONCLUSIONS.

The bacillus of Koch inoculated, whether beneath the skin or into the stomach, constantly occasions death in guinea-pigs without producing any of the characteristic clinical symptoms of cholera, if we exclude lowering of the temperature, which, however, in guinea-pigs has no great importance, for disturbances of any kind may produce it.



By hypodermic inoculations death supervenes through a general infection. The comma bacillus was present in all the organs, including the intestines. With respect to the intestinal canal, at the autopsy only a slight catarrh of the duodenum and a short portion of the small intestine was found.

On the contrary, following the inoculations by the stomach, the anatomical characters of cholera were found, and in no organ, except that of the digestive tube, was it possible to find comma bacilli. Therefore the bacillus of Koch, if it is not the real cause of cholera, is certainly capable of determining in guinea-pigs an infection which, although it is limited to the intestinal canal, determines the anatomical lesions characteristic of cholera and the death of the animal in 24 to 48 hours.

With respect to the bacillus of Emmerich, inoculated under the skin it produces death with the clinical symptoms of a septicæmia. In the first stage, elevation of temperature, weakening of respiration, a general restlessness; and in the second stage, notable lowering of the temperature, prostration of strength, cerebral depression, and death. At the autopsy, with respect to the intestinal canal, only anatomical lesions of an acute catarrh of the duodenum are found.

Inoculated into the stomach after the method of Koch it is either harmless or, penetrating the intestinal wall, enters the blood and occasions the same effects as by hypodermic injection.

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#### REPORT ON RESEARCHES CONCERNING CHOLERA.

BY PATERNO.

Paterno (*Ann. di chim. e di farm.*, No. 2, Feb., 1886) presented a summary report upon the scientific researches concerning cholera which have been conducted in the chemical laboratory of the University of Palermo during the last epidemic. The experiments may be divided into three groups: 1st, those performed by Drs. Emmerich and Buchner more particularly bearing upon the nature of the specific agent of cholera; 2d, those of Dr. Coppola upon the comparative action within the animal organism of the bacteria of Koch and of Emmerich; 3d, those of Drs. Leone and Oliveri upon the drinking water of our city. Besides these researches others were undertaken concerning the soil and the air, in order to discover the action which these vehicles might exercise in the propagation of cholera; others still were initiated for the purpose of isolating from the vomit, from the urine, and from the fæces of cholera patients the poisonous alkaloids which according to some are produced in cholera and are the direct cause of death; and finally others directed to the study of the products of decomposition in albuminous substances and in the nutrient gelatine occasioned by the influence of the development of the bacillus of Koch; but such experiments could not be conducted to a consummation because they should have been performed during the height of the epidemic, when I and my assistants in the laboratory were otherwise occupied in combating the disease.

#### EXPERIENCE OF DRS. EMMERICH AND BUCHNER.

It is known that Emmerich does not recognize the comma bacillus of Koch as the real pathogenic agent of cholera, and that he ascribes that agency to another bacillus of smaller size, which was met with in the blood and organs of cholera patients during the epidemic of Naples of the last year. The new experiments performed between the 20th and 31st of October in my laboratory have led to the following results: In the internal organs (liver, spleen, and kidneys) and in the blood of the heart in the majority of cases of acute cholera no micro-organisms were found; only once in the liver were the "Naples bacilli" found. These bacilli were not found in the serum of the pericardium or peritoneal cavity, nor even in the viscid matter which in cases of typical cholera covers the abdominal organs. In the contents of the intestines and stomach the comma bacillus of Koch was always found (the authors employed a new method of research by which they obtained the comma bacilli in cultures almost pure

within twelve to eighteen hours). In the contents of the stomach and intestines, however, a great number of bacilli whose colonies are altogether identical to those of the "Naples bacillus" was found in the majority of cases. Finally a special examination of the lungs, which according to the ideas of Pettenkoffer are the organs through which the disease invades the body, was made; in some cases the results were negative, but in the majority a large number of colonies of the "Naples bacillus" was found, but they were markedly modified and attenuated.

#### EXPERIMENTS OF DR. COPPOLA.

Dr. Coppola, in order to contribute to the settlement of the question between Koch and Emmerich as to which bacillus may be the real cause of cholera, has compared the results which the comma bacillus and the "Naples bacillus" produce by inoculation into animals, having used perfectly pure cultures, furnished him by Emmerich himself. He has performed two series of experiments, practicing both hypodermic injections and injections into the stomach, after the method of Koch. The results obtained may be thus summarized: The bacillus of Koch, whether injected beneath the skin or into the stomach, constantly occasions the death of guinea-pigs without any clinical symptoms of cholera, if lowering of the temperature is excepted, and to which phenomenon they are naturally subject; after hypodermic inoculation death occurs through general infection, and the comma bacillus is found in all the organs and intestines, which latter present the anatomical signs of a slight catarrh limited to the duodenum and to a small portion of the ileum; on the other hand, as a consequence of inoculation into the stomach the anatomical characteristics of cholera are found at the autopsy, and the comma bacilli are found only in the digestive tract. As to the bacillus of Emmerich, inoculated beneath the skin, death is produced with the clinical symptoms of septicæmia; in the first stage there is elevation of temperature, difficulty of respiration, and general restlessness; in the second stage, notable lowering of the temperature, prostration of strength, and cerebral depression, followed by death. Inoculation into the stomach, after Koch, either remained harmless or the bacilli escaped from the intestines into the blood and determined the same effects as those of the hypodermic injection.

#### EXPERIMENTS UPON WATER BY DRS. LEONE AND OLIVERI.

In these researches the method of Koch has been followed, and another method, due to Dr. Buchner, which consists in using as a culture fluid a sterilized mixture of one part of nutritive gelatine with five parts of a solution of chloride of sodium of 1.02 per cent.; in this fluid the bacilli of Koch develop well, whilst the other micro-organisms grow only with difficulty.

The water examined was obtained from places most infected and during the time that the epidemic was most active.

Now, notwithstanding the experiments were repeated, the presence of the comma bacillus could not be demonstrated in any specimen of water. But it was shown that among other bacteria the water contained one form whose plate and tube cultures showed colonies very similar to those of the bacillus of Koch, so much so as to render distinction difficult; yet in the microscopic examination the distinction is easy, because the individuals are less curved and are plumper than the bacillus of Koch; moreover, cultures of this bacterium when injected into guinea-pigs, after the method of Koch, were harmless.

Drs. Leone and Oliveri have also studied the power of resistance and the power of propagation of the bacillus of Koch in potable water, and have arrived at the result that these bacilli live and grow as well in distilled as in ordinary water side by side with all the micro-organisms which the latter contain. Furthermore, in order to form an idea of the degree of the contamination of the drinking water of Palermo, they obtained water both at the original sources and at the public fountains of the city; at once the bacteriological analysis enabled them to determine that the water of the Popireto, Fontanella, and Garrafello contained in each cubic centimeter from 17 to 30 organisms, whilst that which flowed in the Piazza Garrafello,



Tarzena del Monte, S. Francesco, and in Formari Street, which come from the above-mentioned springs, contained in each cubic centimeter from 79 to 106 micro-organisms. The water, therefore, is markedly contaminated during its short course.

Finally Drs. Leone and Oliveri initiated experiments upon the products of decomposition in bouillon cultures and upon bacteria of water in comparison with those of Koch and of the dejecta of cholera patients; but these experiments have not yet been concluded.

Dr. Leone then continued his investigations undertaken at Monaco upon the behavior of micro-organisms in water; he had proved that the water of Mangfall, which when first obtained contains 5 micro-organisms per cubic centimeter, after 5 days contained more than 500,000 of them, but after the fifth day this number began again to diminish, and after a month it had decreased to 120,000, and after 3 months the number was only 95,000; he had found that carbonic acid retarded this rapid increase of micro-organisms. Confirming now his previous results, he has been able to prove that as well in ordinary water as in water charged with carbonic acid those micro-organisms which are not capable of producing spores end finally by disappearing completely, whilst those which do produce spores resist much longer, with the sole difference that from the first in water containing no carbonic acid a rapid increase takes place, which ceases when all the nutrient material is consumed.

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#### INVESTIGATIONS OF THE CHOLERA BACILLUS IN SHANGHAI.\*

During the summer of 1885 an epidemic of cholera occurred at Shanghai, and proved fatal to a considerable number of Chinese residents. Dr. McCleod and Mr. Mills, who are associated in practice at Shanghai, and whose names ought to be familiar to some of our most experienced bacteriologists in London, with whom they were co-workers here, seized the opportunity of investigating cholera from the bacterial aspect of the question. Their full report is not yet ready, but a preliminary statement, prepared by Dr. Henderson, the health officer of Shanghai, has been published in the report of the municipal governor of that city. The statement briefly sets forth that the investigation was one for the purpose of testing Dr. Koch's results. His methods were employed upon 27 cases of Asiatic cholera, 7 cases of diarrhoea, 2 cases of dysentery, and 4 specimens of healthy saliva.

The following are some of the results :

(1) Koch's comma bacilli, distinguished by (*a*) shape and size, as seen in specimens of the stools under the microscope, and (*b*) by vital characteristics furnished by growth in pure cultivations, were found in 25 out of the 27 cases of cholera; in 2 cases it was not found, but in these the stools were not collected during the stage of collapse and were not characteristic, being foetid and faecal (the bacilli found in the rice-water stools of a given case is frequently absented from the later non-characteristic stools of the same case).

(2) Microscopic examination of the stools of 7 cases of diarrhoea and 2 cases of dysentery, also of 4 specimens of saliva from healthy individuals, demonstrated the presence of comma-shaped bacilli, but in them the cultivation test, which had succeeded in the cholera cases, failed in every instance, thus proving that, though identical as to size and shape, they differed in the more important vital characteristics of growth under the same conditions.

(3) The rice-water stools, as they are called—that is, the characteristic stools of cholera—always contained these organisms, even in an almost pure cultivation of them, few if any others being present, whilst in the less characteristic stools of the later stages of the disease they were difficult of detection and sometimes absent, there being as many as four or five other micro-organisms present.

(4) The organism was not found in this disease in the intestinal wall, as stated by Koch, but, as he has not published his method of detecting it in that position, failure may have been due to a different method of examination.

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\* From the British Medical Journal, July 3, 1886.

(5) The organism was destroyed by being dried, whilst it was found capable of growth after being kept moist for more than 4 months. Probably it is capable of much longer preservation in this state.

(6) The bacilli grew luxuriantly at a temperature from 75° to 100° Fahrenheit, slowly between 50° and 60° Fahrenheit, slightly or not at all below 40° Fahrenheit, but were still capable of resuming growth when the temperature was raised. A series of experiments for the production of the disease in guinea-pigs is now being conducted, but is not advanced sufficiently for this report.

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ON THE EFFECTS SOMETIMES FOLLOWING INJECTION OF CHOLERAIC COMMA BACILLI INTO THE SUBCUTANEOUS TISSUES OF GUINEA-PIGS.

By Surgeon-Major D. D. CUNNINGHAM, M. B., *special assistant to the sanitary commissioner with the Government of India.\**

During the course of the past few weeks I have met with a series of phenomena in certain experiments on the subcutaneous injection of choleraic bacilli into the bodies of guinea-pigs which appear to be sufficiently remarkable to merit special record. I propose, therefore, in the present paper to give a detailed account of these experiments and their results along with a few brief notes regarding their apparent significance.

I.—SOURCE OF THE MATERIAL EMPLOYED IN THE EXPERIMENTS.

The commas employed in all the experiments belonged to a series of cultivations originally derived from a case of cholera which was admitted into the medical college hospital on the 21st of January, 1886. A portion of a fresh evacuation was sent to me for examination on that day. It consisted of a brownish-gray alkaline, watery fluid, and an abundant sediment of gelatinous somewhat pinkish flocculi.

The examination of fresh preparations made immediately on the arrival of the material showed that it was crowded with schizomycete organisms of various forms. Commas were only present in very small numbers, and constituted a very inconspicuous feature as compared with other forms.

In spite of this, however, a plate cultivation yielded what was practically a pure crop of the commatous colonies. These were present in innumerable numbers, and the only other form of colonies recognizable were two or three, consisting of a very large kind of micrococcus which was present as a conspicuous feature in the original material. This plate afforded the starting-point for a series of successive tube cultivations of the commas which were employed in the experiments.

II.—DETAILS OF THE INDIVIDUAL EXPERIMENTS.

EXPERIMENT 1.

On the 9th of February a healthy guinea-pig, weighing 482 grams, received a subcutaneous injection of a little less than 1 cubic centimeter of fluid, consisting of sterilized 0.8 per cent. salt solution full of commas derived from a pure tube cultivation of commas of four days' standing. The site of injection was the inner surface of the left thigh. Every precaution was taken to avoid any accidental contamination. The syringe which was employed had been immediately beforehand soaked in strong carbolic acid, and then thoroughly washed in rectified spirit and in freshly boiled, distilled water. The site of injection was cleared of hair and carefully washed with solution of corrosive sublimate and with spirit, and the skin was drawn aside ere the introduction of the point of the syringe, so as to secure a valvular action on its subsequent release.

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\*Scientific Memoirs of Medical Officers of the Army of India. Calcutta, April 16, 1886.



On the 10th of February the animal appeared to be unaffected, save that it was slightly lame in the injected extremity. On the 11th of February at 9 a. m., however, it was conspicuously affected. It was lying down, and constantly uttering peculiar sharp cries, as though in pain. It evidently felt cold and its respirations were very rapid. There were constantly recurring peculiar twitching movements of the abdominal and aural muscles, and evidences of pain on any pressure of the abdominal walls. In the afternoon at 4 p. m. it was still alive. The general symptoms were much the same as in the morning. It was unable to stand or walk, the eyes were much sunken, the surface of the body sensibly cold to touch, and it was constantly squeaking feebly.

It died during the course of the night, and the body was examined at 10 a. m. on the 12th of February. The total body weight was 429 grams, so that there had been a loss in weight of almost exactly 11 per cent. since the operation. The weights of the body and of various organs are shown in the following table :

Organs.	Weight (in grams).	Per cent. of total weight.
Liver .....	29	6.7
Spleen .....	1.8	.419
Right kidney .....	3	.69
Left kidney .....	2.8	.65
Right lung .....	2	.46
Left lung .....	1.9	.44
Heart .....	3.8	.88

The next table shows the corresponding weights in the body of a healthy guinea-pig in which they were specially determined. Total body weight, 452 grams :

Organs.	Weight (in grams).	Per cent. of total weight.
Liver .....	32.36	7.1
Spleen .....	0.44	.09
Right kidney .....	1.86	.41
Left kidney .....	1.9	.42
Right lung .....	1.64	.36
Left lung .....	1.24	.27

On comparing the above series of figures it is evident that in this case there was slight diminution in the relative weight of the liver and increase in the weights of all the other organs and specially in that of the spleen.

On removing the skin a large patch of sanguineous effusion became visible, thickest over the site of injection, and spreading up thence over the lower half of the abdomen on the same side. On opening the abdominal cavity the surface of the peritoneum was found to be coated with a thin stratum of sticky secretion, very similar to that present in many cases of cholera. This caused the surfaces of the viscera to adhere more or less to one another, but there was an absence of fluid, of congestion, or of adhesions of a characteristically peritonitic character. The stomach was pale, and contained a mixture of gelatinous, transparent mucus and brown grumous matter. The small intestine was empty, the mucous surface being pale and very moist, and here and there covered by patches of brownish mucus. The cæcum contained a considerable quantity of soft, pale amber contents, which seemed to be rather drier than normal. The reaction was neutral. The rest of the large intestine was pale and empty, save towards the lower end, where one or two formed fecal pellets were present. The liver was rather pale and the gall-bladder distended with pale-yellowish bile. The spleen was dark red and the kidneys were congested. On opening the thoracic cavity the lungs were found to be pale pink and free from congestion or extravasations. The right side of the heart was distended with blood.

A series of preparations of the materials of the subcutaneous sanguineous effusion, of the peritoneal secretion, the cardiac blood, and the contents of the large and small intestine was made with the following results :

- (1) *Subcutaneous sanguineous effusion*.—This was full of comma bacilli.
- (2) *Peritoneal secretion*.—This also contained abundant characteristic commas.
- (3) *Cardiac blood*.—No commas or other schizomycetes were to be found.
- (4) *Intestinal contents*.—The material derived from the small intestine consisted of some of the brownish mucus previously alluded to, obtained from a patch of it situated in the ileum.

It only contained a very few recognizable epithelial elements, the greater part consisting of amorphous mucoid matter. In this basis very large numbers of characteristic small commas were present. Some of them were irregularly scattered through the basis ; a large number of them, however, were associated in small groups, and some of these were clearly specially related to large nuclear bodies, the commas being aggregated on and around these.

In such cases it was clearly evident that one was dealing with bodies parallel to those described by Drs. Klein and Gibbes in connection with the small straight bacilli which they have pointed out as a characteristic feature in choleraic materials. The mucus from the large intestine also contained small commas, but not at all in such large proportion, and the large curved forms normally present there occurred in relatively very small numbers only.

Various cultivations were carried out with the following results:

- (1) A plate cultivation of the subcutaneous sanguineous effusion yielded a pure crop of abundant commatous colonies.
- (2) A plate cultivation of mucus from the ileum yielded a crop of commas mingled with colonies of short, straight bacilli.
- (3) A plate cultivation of materials from the cæcum gave similar results.
- (4) A tube cultivation of cardiac blood obtained by direct perforation of the right side of the heart by the point of a freshly-drawn capillary pipette, the point being broken with the cardiac cavity, and direct inoculation of an agar-agar tube being subsequently carried out. This yielded a pure crop of commas.

An extensive series of preparations of various tissues which had been preserved in alcohol was subsequently carefully examined. In spite of varied methods of staining, no traces of the presence of commatous or other schizomycete forms could be detected in the substance of the liver, spleen, kidneys, or lungs. The mucous membrane of the small and large intestines appeared to be normal. There was no recognizable evidence of the occurrence of any extensive desquamation of epithelial elements, and the tissues of the intestinal wall were free from any signs of invasion by commas.

#### EXPERIMENT 2.

A healthy female guinea-pig weighing 868 grammes was inoculated by the subcutaneous injection of about 0.5 cubic centimeter of sterilized 0.85 per cent. salt solution full of commas. These were obtained from a pure tube of a cultivation derived from the primary tube cultivation of the cardiac blood of the previous animal. The operation was performed on the 17th of February, and was carried out with the same antiseptic precautions as in the previous case. The syringe employed was a different one. On the morning of the 18th the animal aborted, producing three immature young, and when first seen it was slightly lame. At 4.30 p. m. it was lame, its respirations were between 90 and 100 per minute; it was inclined to lie still, and its eyes were somewhat sunken.

It died during the night, and the body was examined at 11.45 a. m. on the 19th of February. The weights of the principal abdominal and thoracic organs were as follows :

	Grammes.
Liver.....	29.42
Spleen.....	.52
Right kidney.....	2.6
Left kidney.....	2.55
Right lung.....	3.52
Left lung.....	2.55
Heart.....	3.87



The appearances generally were similar to those in the previous case. There was subcutaneous sanguineous effusion in the site of the injection, which, as in the previous case, was in the inner aspect of the left thigh, and extending thence over the lower half of the abdomen on both sides.

The peritoneal surface was covered by a thin, sticky, transparent secretion which caused the folds of the intestine to adhere to one another. The small intestine was almost empty, and the surface of its mucous membrane was very moist. The cæcum contained material like that in the previous case. The upper portion of the colon was empty, but towards the lower end there were a few formed fæcal pellets. The liver was pale colored and the gall-bladder full of pale, watery, yellowish fluid. The spleen was dark red. The kidneys were firm in texture, and normal in color. The lungs were pale, save towards the lower part of the left one, where some patches of congestion were present. The right side of the heart was gorged with blood. Preparations were made at once of the subcutaneous sanguineous effusion, the peritoneal secretion, the cardiac blood, and the intestinal contents.

The subcutaneous effusion was full of commas. The peritoneal secretion also contained an abundance of them. None could be recognized in the cardiac blood. The mucus from the ileum contained numerous disintegrating epithelial elements. Commas were evenly sprinkled through it, but were not present in such great numbers as in the previous case. The contents of the large intestine resembled those in the previous case in general character. Cultivations gave the following results:

(1) A tube cultivation of the peritoneal secretion gave an abundant and very rapidly growing crop of pure commas.

(2) All three punctures in a tube inoculated with cardiac blood as in the previous case yielded pure crops of commas.

(3) A plate cultivation of the ileac mucus yielded an almost pure crop consisting of innumerable, small, commatous colonies.

The microscopic examination of the tissues and organs also gave results similar to those in the previous case. As in it, there was no evidence of the presence of any schizomycetes in the substance of the intestinal walls. There were, however, appearances indicative of a greater tendency to epithelial desquamation—appearances quite corresponding with the comparatively large numbers of detached elements present in the mucus.

#### EXPERIMENT 3.

A healthy guinea-pig weighing 650 grammes was subcutaneously inoculated with a drop of sterilized 0.8 salt solution full of commas belonging to a secondary tube cultivation of pure commas derived from the iliac mucus of the previous case. The operation was performed at noon on the 23d of February. The animal was apparently unaffected, but a considerable loss of weight occurred, as on the 26th February it weighed only 619 grammes. On the 1st March its weight had increased to 629 grammes, and it was then inoculated subcutaneously in the right thigh with 0.33 c. c. of material derived from a tertiary tube of a week's growth of commas derived from the iliac mucus in Experiment 2. The animal appeared to be unaffected, but a fresh considerable loss of weight occurred, so that on the 4th March it only weighed 595 grammes. A fresh inoculation was then carried out, 1 c. c. of fluid full of commas from a tube cultivation derived from the peritoneal secretion of the guinea-pig of Experiment 2, being injected into the subcutaneous tissue of the abdominal region. No result followed, and on the 8th March the body weight had gone up to 620 grammes.

The animal was then killed, and the body examined with the following results:

*Weights of various organs.*

	Grammes.
Liver.....	30.11
Spleen.....	.7
Right kidney.....	2.38
Left kidney.....	2.47
Right lung.....	1.68
Left lung.....	1.41
Heart.....	3.75

On removing the skin there were slight evidences of a limited amount of inflammatory effusion in the sites of the two later injections in the right groin and anterior abdominal surface.

The peritoneal surface was smooth, moist, and entirely free from the sticky secretion present in the two previous cases. The stomach was full of undigested food. The small intestine contained soft greenish-brown food substance. Peyer's patches were conspicuous and prominent on the mucous surface. The cæcum was full of rather pale, greenish-brown pulp, and the colon throughout contained normal fæcal pellets in its pouches. The liver was soft in texture and very full of blood. The gall-bladder contained pale-yellow bile. The kidneys were full of blood. The spleen was dark red. The lungs collapsed freely and were then pale throughout.

Fresh preparations of the remains of subcutaneous effusion and of the peritoneal secretion and blood failed to show any commas, and tube cultivations of cardiac blood, of the subcutaneous effusion and the peritoneal secretion, did not produce any.

## EXPERIMENT 4.

A healthy guinea-pig inoculated on the 8th of March. The weight of the animal was 776 grammes, and 1 c. c. of fluid full of commas from a pure tube cultivation of the original choleraic commas of 48 hours' growth was injected subcutaneously in the left thigh.

No conspicuous results followed, but as usual there was a considerable loss of weight. On the 12th of March, when the weight was 700 grammes, about 1 c. c. of fluid full of commas belonging to the series of cultivation of the original choleraic material was injected into the peritoneal cavity. No apparent effects were produced and the animal was accordingly killed on the 15th of March.

The total body weight was then 720 grammes, and the weights of various organs were as follows:

	Grammes.
Liver.....	37.07
Spleen.....	.8
Right kidney.....	2.4
Left kidney.....	2.37
Right lung.....	2.77
Left lung.....	2.02
Heart.....	4.2

There was a large amount of sanguineous, subcutaneous effusion spreading upwards over the lower part of the abdomen from the site of original inoculation in the left groin.

The peritoneal surface was normal and devoid of any sticky secretion or signs of inflammatory action. The stomach was full of undigested food. The small intestine presented normal appearances. The cæcum and upper portion of the colon were full of soft, greenish-grey, pulpy matter, and the lower portion of the colon contained normal, formed fæcal pellets.

Fresh preparations of the subcutaneous effusion, of the peritoneal secretion, of cardiac blood, and of the contents of the intestinal tube, were examined. Unequivocal commas were absent alike from the subcutaneous effusion, the peritoneal secretion, and the cardiac blood. The intestinal contents presented normal microscopic features, and, especially as regards those related to the large intestine, contained an abundance of the commatous forms normally occurring in them in health. Tube cultivations of the subcutaneous effusion, the peritoneal



secretion, and the cardiac blood, agreed in failing to yield any commas. A similar result followed in the case of plate cultivations of materials derived from the contents of the ileum, cæcum, and colon. A very extensive series of preparations were made from these, and numerous successive cultivations were carried out, but the results were merely those characteristic of cultivations of the normal intestinal contents. In not a single case could any growth of commas be detected among the comparatively limited number of colonies of any kind which were developed.

#### EXPERIMENT 5.

A small healthy guinea-pig weighing 300 grammes was inoculated with about 1 c. c. of fluid containing commas from a cultivation of the original choleraic series of 6 days' duration. The material was injected into the subcutaneous tissue of the inner surface of the left thigh, and all the details of the operation were carried out as usual. On the following day the animal was lively and apparently quite unaffected. On the 20th of March, 48 hours after the operation, it was in the same condition. On the following morning, however, it was decidedly affected. The abdomen appeared to be somewhat swollen and it was suffering from diarrhoea.

It died during the course of the following night, and the body was examined at 10 a. m. on the 22d.

The body was perfectly fresh and *post mortem* rigidity was well marked. The total weight of the body was 263 grammes. The weights of the principal thoracic and abdominal organs were as follows:

	Grammes.
Liver .....	15. 22
Spleen .....	. 6
Right kidney .....	1. 25
Left kidney .....	1. 3
Right lung .....	1. 7
Left lung .....	1. 35
Heart .....	1. 8

On removing the skin the subcutaneous tissue over the entire anterior surface of the abdomen and thorax was found to be deeply congested, and the masses of sanguineous effusion were present in the groins and axillæ. The peritoneal cavity contained no fluid, nor were any defined adhesions present, but the surface was everywhere covered by a thin layer of sticky material, which caused the loops of the intestine to adhere to one another where in contact. The parietal stratum was pinkish and slightly congested. The small intestines were full throughout of a watery fluid full of fine whitish or yellowish flocculi. In the ileum the accumulation of fluid was so considerable as to cause a certain amount of actual distention. The intestinal walls were pale, and, on laying open the canal, they were manifestly abnormally thin. The stomach contained fluid like that in the small intestine. The cæcum was half full of thick, frothy fluid of a pale greenish-gray color. Similar fluid was present in the upper part of the colon, but in the lower part a few scattered, more or less formed, pale pellets were present.

The liver and kidneys were somewhat pale. The spleen was relatively rather large and of a dull red color. The lungs appeared to be normal. The right half of the heart was full of blood.

Immediate examinations were made of the subcutaneous effusion, the peritoneal secretion, the cardiac blood, and the intestinal contents. The subcutaneous effusion was full of characteristic commas. The peritoneal secretion was also crowded with them. Many of them here were of large size and abnormal form, many of these being evidently connected with the process of multiplication by longitudinal division—using this term as applicable to that form of division, first pointed out by Dr. Klein, in which there is a tendency to the assumption of a circular figure preparatory to division. The cardiac blood failed to show any recognizable commas.

The contents of the small intestine were crowded with desquamated epithelium in the form of isolated cells and masses of adherent ones. In the fluid from the ileum commas of characteristic form were present in innumerable numbers, and so few schizomycetes of any other kind accompanied them that the material might roughly be described as representing a pure cultivation of commas. In the contents of the duodenum numerous commas were also present, but they were associated with great numbers of large, straight, apparently putrefactive bacilli.

The contents of the cæcum were full of desquamated epithelium and contained numerous characteristic commas as well as larger commatous and spirilloid bodies similar to those present under normal circumstances.

Cultivations were carried out with the following results:

(1) A tube cultivation of cardiac blood with three distinct punctures gave a pure crop of commas around each puncture.

(2) A tube cultivation of the peritoneal secretion gave a pure crop of commas.

(3, 4) Two plate cultivations of the contents of the ileum yielded practically pure growths consisting of innumerable colonies of commas. Only one or two colonies of any other kind appeared in either plate.

Hardened specimens of the liver, spleen, kidneys, lungs, and large and small intestines were subsequently examined. The tissues of the liver, spleen, kidneys, and lungs were apparently free of invasion by commas or any other form of schizomycete organisms. Sections of the intestines showed absolute desquamation of the epithelial stratum. The subjacent adenoid tissue appeared to be everywhere completely laid bare, save in one or two rare instances where the deeper extremity of a tubular gland retained some traces of epithelium. No accumulation of commas within the adenoid tissue or the deeper strata could be discovered, and indeed hardly any unequivocal commas could be detected amongst the scattered bacilli which were in some places present in the substance of the exposed adenoid tissue.

We have here 5 cases of the subcutaneous injection of choleraic commas, in 3 of which fatal results ensued. There can, I believe, be no reasonable doubt that the commas exerted a specific pathogenic influence in these cases. The general uniformity of the lesions present in all of them, together with the fact of the general systemic diffusion of the commas, appears to be conclusive in regard to this point.

The results are such as would appear to prove conclusively that subcutaneous injections of commatous media are not unattended with possible risks. When, however, we come to consider the matter further, we encounter two questions calling for separate consideration. These are, first, how far are these results confirmatory of a belief in the causative relation of the comma bacilli to cholera? And, second, how are we to account for the exemption of two of the animals experimented with?

The fact that the choleraic commas are, under certain circumstances, pathogenic is one thing, that they are the efficient cause of cholera is quite another. In dealing with the symptoms manifesting themselves in any such experiments as the above, we are at the outset encountered by doubts as to the extent to which we are entitled to expect any exact uniformity of symptoms in animals of unlike nature and habits, and how far we are justified in tracing parallelisms in symptoms of differing characters. The same holds good, to a certain extent at all events, in regard to the lesions revealed by *post-mortem* examinations.

Allowing all this due weight, there were apparently in these cases of disease following the subcutaneous introduction of choleraic commas into the system, certain points of similarity to, or even of close agreement with, cases of cholera. So far as the symptoms are concerned, there was in the first case unquestionably considerable depression of surface temperature with frequent muscular twitchings, if not actual cramps, and, both in it and the next one, there was marked sinking of the eyeballs. In the third case, on the other hand, there was distinct diarrhœa. In all of them, as in cases of cholera, comma bacilli were present in large numbers in the contents of the intestinal canal. The mere presence of curved bacilli would, of course, have been of no special significance, as such bodies are unequivocally present in considerable numbers within the intestines of healthy guinea-pigs. But while such commas, in so far as my



experience goes, are incapable of cultivation in the agar-agar or gelatine media favorable to the growth of choleraic commas, those present in these cases are readily cultivable, and the pure cultivations of them in various media are identical in macroscopic and microscopic characters with choleraic ones. [It will be remembered that Klein places great stress, while antagonizing Koch, upon some experiments in which comma bacilli develop in the intestine of the guinea-pig without reference to cholera. Klein implies that these commas are not different from those of Koch. As is seen, his distinguished East India confrère recognizes these two forms of curved bacilli as entirely different species.—E. O. S.] In 2 cases, moreover, desquamation of the epithelial lining of the intestinal canal formed a conspicuous feature, and although in one of them the process had certainly not advanced very far, in the other it had taken place as completely as it ever does even in those cases of cholera in which it attains its maximum development. Other minor points of resemblance are to be found in the great loss in body weight quite apart from any diarrhoea, and in the absence of any direct evidence of the presence of commas in the liver, kidneys, spleen, or blood. The condition of the serous surfaces of the peritoneal cavity was also so far similar to that present in cholera in that they were covered with a thin layer of peculiar adhesive secretion.

On the other hand, this secretion is sharply defined from that normal to cases of cholera, owing to the presence of abundance of commas in it. The results of cultivations of the cardiac blood, moreover, differ from those in cholera, as, although no commas were ever recognizable in the fresh blood, cultivations always gave pure crops of such bodies. In regard to this point, however, it is just possible that the commas were really derived from the serous surface of the pericardium, and not from the interior of the heart. The materials for cultivation were always obtained by passing the end of a freshly drawn and hermetically sealed capillary pipette through the walls of the auricle, and subsequently breaking off the closed tip within the cardiac cavity. Now, as the external surface of the heart was in no case disinfected previously, it remains possible that the results of the cultivation were due to commas derived from the pericardium and adhering to the exterior of the pipette. The extensive subcutaneous effusion of sanguineous material full of commas which formed such a characteristic feature in all three cases is unlike any phenomenon normal to cases of cholera. The condition of the spleen, too, is, if anything, rather adverse to the acceptance of the choleraic nature of the affection, as there appeared to be a decided tendency to splenic enlargement in two of the cases, at all events, and such a condition is suggestive rather of septicæmia than of cholera.

Taking everything into consideration, however, there yet appears to be a considerable probability that the disease in these cases was in many ways closely related to cholera. The points of agreement between the two morbid conditions seem to me to be very noteworthy, and the deviations may possibly be ascribable to the nature of the animals experimented with the quantity of the pathogenic medium introduced and the site of its introduction.

One thing is very clearly demonstrated by the results of these experiments, and that is that the sites of an organism in which pathogenic schizomycetes are ultimately to be encountered in greatest abundance by no means necessarily correspond with those of primary invasion of the system. In all these cases comma bacilli of identical nature with those originally introduced were ultimately present in great, and in one case in excessive abundance, within the cavity of the intestinal tube, whilst in all cases alike the site of primary invasion was the subcutaneous tissue.

It must, I think, be granted that the commas present within the intestinal cavity were the descendants of those which were introduced into the subcutaneous tissue, and, from the abundance of similar bodies present in the peritoneal secretion it would appear that the path which they followed in their systemic diffusion was from the subcutaneous lymphatic spaces to the great peritoneal one, and thence by direct penetration of the walls of the intestinal tube to its cavity. All direct evidence of such a process of penetration is, however, wanting, for the most careful examination of numerous sections of the intestinal walls failed in every instance to show any evidence of special accumulations of commas in their thickness. It is,

of course, possible that the period of transit may have preceded that at which death took place, or that transference only occurred in the case of a very few commas which subsequently by processes of multiplication gave origin to the multitudes ultimately present within the cavity of the intestinal canal. There remains, further, the possibility that the transit may have taken place, not by a process of general diffusion, but by the agency of special carrier-protoplasts, which, after taking up the commas by ingestion while within the peritoneal cavity, subsequently traversed the walls of the intestinal tube and died within its cavity, freeing their bacillar contents in a condition fit for processes of rapid growth and multiplication. That such a process of transit actually did occur, to some extent at all events, in these cases is rendered probable by the phenomena presented by the ileac mucus in Experiment 1. In this, as previously mentioned, numerous bodies, similar to those pointed out by Drs. Klein and Gibbes as occurring in choleraic media, were present. These consisted of large nuclear bodies, with more or less evident remains of cell protoplasm around them, in which numbers of small bacilli were present. *These were, however, in this instance unequivocally minute commas and not straight bacilli as in the choleraic media.* The results of the experiments in any case appear definitely to determine that by some means or other actual transit of schizomycete organisms from the tissues outside the intestinal tube to the interior of it may take place so as to give rise to conspicuous effects there without it being possible to obtain any direct evidence of the occurrence of the process.

But another important fact is established by these experiments for all those who assume that the choleraic commas are the actual cause of cholera. The experiments clearly show that pathogenic effects may arise as the result of the access of these bacilli to the lymphatic system, and that therefore the site of primary infection in cases of cholera need not necessarily be the digestive tract. It may, of course, be urged that spreading lymphatic invasion, such as was present in these cases, is not a phenomenon normal to cholera, and that it is therefore one aside of the question as regards the invasion of the system in that disease. This objection, however, ceases to carry any weight when we recollect that as an ultimate outcome of this lymphatic invasion we have the access of commas to the interior of the intestinal canal and their extensive multiplication within it; for, even granting that the true choleraic condition is only initiated by such processes, the fact remains that they may be due, not to direct invasion of the interior of the digestive tract by the ingestion of materials from the external world, but to invasion from the surrounding tissues.

The question regarding the cause of the immunity of two of the animals experimented with must in the meantime remain a subject for conjecture only. The immunity must clearly have been due either to special conditions in the inoculated animals or to special conditions in the material which was introduced into their system. If the phenomenon were due to any subjective peculiarity in the animals there was, at all events, no direct evidence of its existence, unless we are to regard the fact that the exempt animals were somewhat larger than those in two of the fatal cases and were not pregnant as the animal in the third fatal case was, as equivalent to this. The actual weights of the animals and the amount of commatous fluid injected in each case are shown below:

No. of experiment.	Result.	Body weight.	Fluid injected.
1.....	Fatal .....	482	1 c. c.
2.....	...do .....	868	.5 c. c.
		650	1 drop.
3 .....	Nothing ....	629	.33 c. c.
		595	1 c. c.
4.....	...do .....	776	1 c. c.
		700	1 c. c.
5.....	Fatal .....	300	1 c. c.



The above figures certainly show that, leaving the case of the pregnant animal out of consideration, the relative amount of commatous material introduced at any one time was higher in the animals which suffered than in those which remained exempt. The numbers which have to be dealt with are, however, too few to form the basis for any definite conclusion, and the matter clearly requires further experimental investigation.

In reference to the question of possible dependence of the exemption on special quality of the injected material, it must be pointed out primarily that there certainly could not have been any permanent change or deterioration, for the two cases of exemption occurred not at the close of the series of experiments, but between the two first and the last fatal case in which the material employed belonged to a cultivation of later date than those which failed to exhibit pathogenic properties. The possibility that the exemption was due to any peculiarity in the substratum capable either of directly modifying the characters of the bacilli or of modifying the nature of the decomposition products connected with their growth, is also excluded by the fact that the substratum connected with the last fatal case was identical with that related to the two cases of exemption. In other words, the agar-agar meat-juice gelatine in the cultivations related to the two cases of exemption and to the last fatal case belonged to one batch of tubes.

The only hypothesis remaining, then, on the assumption that the exemption was due to the peculiarities in the material injected, is that this presented temporary differences in the two classes of cases—that in those cases where pathogenic phenomena manifested themselves the bacilli were either a more resistant and adaptable to their new site, or had manufactured special decomposition products, or specially large amounts of decomposition products favoring their invasion of the host-organism. In regard to this point also we have unfortunately not sufficient data to enable us to arrive at any definite decision. The only phenomenon which was in any way noteworthy in reference to it is that, in all the cases in which pathogenic results presented themselves, the cultivations from which the materials for injection were obtained had very conspicuously passed on into the stage characterized by the occurrence of vacuolation and other deviations from the normal form in the commas, and that in one, at all events, of the cases of exemption, the material belonged to a very recent cultivation in which such phenomena had not begun to manifest themselves.

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#### EXPERIMENTS WITH KOCH'S CHOLERA BACILLI.

By D. D. CUNNINGHAM, of Calcutta.\*

The second part of the scientific Memoirs of the Medical Officers of the Army of India contains an interesting account of further experiments by Dr. D. D. Cunningham with cholera comma bacilli. In the present paper Dr. Cunningham mentions experiments by the subcutaneous injections of this organisms into guinea-pigs. The bacilli employed were obtained from a case of cholera on June 21, 1886, and the material used for injection was a mixture of bacilli in .8 per cent. salt solution. Five guinea-pigs were injected with quantities varying from 1 drop to 1 cubic centimeter; 3 of these 5 animals died. The animals were generally well on the following day, but on the second day they became ill and died with symptoms in several points resembling cholera. In 1 case there was considerable depression of temperature, with frequent muscular twitchings; and in 2 cases there was marked shrinking of the eye-balls; in the third case there was distinct diarrhea; in all 3 cases comma bacilli were present in large numbers in the contents of the intestinal canal; in 2 cases desquamation of the epithelial lining of the intestinal canal formed a conspicuous feature. In all there was great loss of weight. The peritoneal cavity contained flakes of lymph in which large numbers of comma bacilli were present; but this is not the case in man. Dr. Cunningham does not commit himself to a definite opinion as to the significance of these facts, yet observes that

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\* British Medical Journal, 4, 2, 1887.

the point of agreement between cholera in man and this morbid condition is very noteworthy, and that the deviations may possibly be ascribable to the nature of the animals experimented with, the quantity of the pathogenic medium introduced, and the site of its introduction.

[This abstract neglects to state that in Dr. Cunningham's experiments he found that those animals which survived the inoculations were found to be protected against the effects of subsequent and larger doses introduced by subcutaneous inoculations, in this particular, as in the other results, independently confirming the original observations of Ferrán concerning the experimental production of immunity from an attack of cholera—a claim which has been especially in France and England vehemently combatted.—E. O. S.]

#### ON MILK AS A MEDIUM FOR CHOLERAIC COMMA BACILLI.

By D. D. CUNNINGHAM, of Calcutta.<sup>1</sup>

Surgeon-Major Cunningham, of Calcutta, in his memoirs publishes a full account of very numerous observations by the aid of the microscope and culture methods on the very important question of the relation of cholera in India to the milk supply. For the details of these researches the reader is referred to his very voluminous paper. At the end of the latter the author briefly summarizes the results of his numerous experiments. In regard to the behavior of milk as a medium for the development of the comma bacilli of Koch, his experiments seem to give results agreeing to a considerable extent with those of Kitasato published in the *Zeitschrift für Hygiene*, 1888.

The author says that the entire series of experiments appear clearly to warrant the following conclusions:

(1) The milk which is in ordinary use in Calcutta normally contains a large number of schizomycete organisms, and in many instances an excessive number of them.

(2) The number of distinct species which are normally present is, however, very limited.

(3) All of these, save the *bacillus subtilis*, are destroyed by boiling the fluid a very short time.

(4) A certain, but apparently usually only a small, number of spores of *bacillus subtilis* is, however, normally present, and these give rise to an excessive development of that species in the boiled milk.

(5) Acid fermentation and coagulation normally occur very rapidly in ordinary specimens of milk.

(6) These phenomena are associated with processes of rapid growth and multiplication of the schizomycete organisms which are destroyed by simple boiling of the fluid, and, therefore, in many cases fail to manifest themselves in boiled specimens.

(7) In certain cases, however, boiling, while demonstrably destroying the common lacteal schizomycetes, with the exception of *bacillus subtilis*, fails to prevent acid fermentation and coagulation.

(8) This is related to the particular stratum of any sample of milk from which the specimens have been obtained—specimens derived from the upper strata having a much greater tendency to undergo acid fermentation and coagulation than those derived from the lower strata.

(9) Cultivations fail to show any differences in the nature of the schizomycetes present in the two areas, and show no important difference in regard to their numbers.

(10) The phenomenon must, thus, apparently be explained either as due to a special accumulation of the ferment, elaborated in connection with the growth of the schizomycete organisms in the upper portions of the fluid, or, more probably, as the result of special accumulation there of those constituents in the milk which are the subjects of the fermentive change which leads to the alteration in reaction and coagulation.

<sup>1</sup>Scientific memoirs of medical officers of the army of India; part v, 1890, Calcutta.



(11) Coagulative changes ultimately occurs in specimens of milk which have been deprived of all their living schizomycete contents but *bacillus subtilis*

(12) This, however, differs in nature from the common coagulation of unboiled specimens in occurring apart from the development of acidity to any considerable extent, or as a constant event, in the fluid, and in the character of the resultant coagula, which form a finely pulverulent deposit in place of the large dense masses occurring in the case of common coagulation.

(13) The measures which suffice to secure true sterilization in milk differ somewhat in different instances, due to differences present in the condition of the bacilli at the time of their application—measures serving to secure sterilization where no spores are present being naturally not necessarily capable of producing the same effect where spores exist.

(14) Complete sterilization can be certainly arrived at by means of subjecting the milk to the temperature of boiling water for some hours, and after this the fluid remains practically permanently unaltered save in undergoing a gradual evaporative diminution in bulk.

(15) The milk in ordinary use in the bazaars and European houses in Calcutta is not a favorable medium for the multiplication or even continued existence of comma bacilli.

(16) Their introduction does not interfere with the normal processes of excessive multiplication of the common lacteal schizomycetes and the acid fermentation accompanying it, and, as the latter advances, the comma bacilli rapidly ceases to multiply and die out, so that, under normal circumstances, the medium is free of living specimens of them within the course of twenty-four hours.

(17) Milk, however, which has been exposed to boiling for a short time becomes a medium in which, for some time, at all events, an excessive multiplication of comma bacilli certainly follows their access.

(18.) The presence of the comma bacilli in such cases seem to exert a temporary repressive influence on the development of the normal content of *bacillus subtilis*.

(19.) The repression is, however, only temporary, and *bacillus subtilis* again becomes very abundant.

(20.) This rejuvenescence of *bacillus subtilis* is sometimes associated with marked decrease in the activity of multiplication of the comma bacilli, or even with their complete suppression, but, in other cases the two species may persist in large numbers in association in the same medium for a period of several weeks' duration.

(21.) Sterilized milk affords an even more favorable nidus for the growth and multiplication of comma bacilli than boiled milk does, apparently due to the protection which it provides against a struggle for existence.

The author further remarks: These facts, beyond their purely scientific interest, appear to have an important bearing practically. They seem to indicate that the ordinary milk supply of the bazaars of Calcutta, and presumably of India generally, furnishes a medium which, from the high degree to which it is normally contaminated by schizomycetes, whose growth is associated with processes of acid fermentation is not at all likely to be favorable to the development or continued existence of those forms which require an alkaline or neutral environment. The very contamination of the fluid comes to render it an unfavorable medium for organisms which, were it pure, would find conditions extremely favorable to their growth and multiplication in it. But, if this be so, unless it were clearly proven that the normal schizomycete population of the milk contains species which are capable, directly or indirectly, of giving rise to disease when they come into relation to the human organism, it can only be regarded as a protective arrangement tending to render the medium unfavorable to the development of other and possibly noxious organisms. It is no doubt unpleasant to realize that the milk supply in India is so highly impure as it unequivocally is, but it does not follow that the contamination is an unmixed evil. For example, if comma bacilli really be the specific cause of cholera, there can be no doubt that the common impurities in milk must tend to render the latter an unfavorable vehicle for the communication of the cause of the disease, and as it is one to which there can be no doubt that comma bacilli are very likely to gain access in any locality in which the disease prevails, those who see in them the essential cause of the disease

must regard the normal contamination, or, in other words, the normal schizomycete population of the milk as playing a beneficent part. The evidence, in so far as it goes, seems to indicate that the ordinary milk supply in this country is an unfavorable medium for schizomycete organisms requiring alkalinity or neutrality in their environment in order to their successful propagation and continued existence apart from the presence of spores, and, this being so, all those who ascribe the development of any disease to the influence of pathogenic schizomycetes may fairly be called on to demonstrate that these are capable of surviving the conditions to which they must normally be exposed on gaining access to milk, ere blaming the latter as a means of communicating the disease. In any case it must be a comfort to realize that if the population of India be condemned to the use of impure milk, the very contamination is likely to act more or less in protective fashion, and is normally due to the presence of organisms which, with the exception of the harmless *bacillus subtilis*, may be completely destroyed by simple boiling.

The reader should consult in connection with this paper what has been already remarked by Dr. Simpson, the health officer of Calcutta, concerning cholera and milk. However laborious Dr. Cunningham's experiments have been, the fact still remains that cholera has spread in Calcutta by means of the milk supply, as Simpson has shown. Moreover, Cunningham's own operations show that the comma bacilli of Koch do live and multiply even in unboiled milk for some time after they have been placed in it. The practical inference from these facts seems to me to be that, although after unboiled milk has been diluted with water containing comma bacilli and then kept for some days, these particular germs may succumb in the struggle with other germs for existence, during the first day of dilution at least such milk is capable of producing an attack of cholera if the cholera bacilli in it pass through the stomach alive. These experiments of Cunningham prove beyond doubt that milk uncontaminated with other living germs, *i. e.*, boiled milk, is an exceedingly good medium for the development of the comma bacilli of Koch. A practical application of this fact seems to me to be not that the milk should not be boiled, but rather that boiled milk should be consumed as food soon after boiling and before it is likely to become again contaminated. There is one circumstance which should be borne well in mind, however, in undertaking to estimate the absolute significance of these observations of Cunningham. It is the fact that there are few places in Europe or America, perhaps even none, where micro-organisms so load the air, earth, and water as they do during spring, summer, and autumn in Calcutta. For this reason it is not only possible but probable that if the same experiments were to be performed either in Europe or America, the unboiled milk which had been inoculated with the cholera bacilli would contain them for a much longer time living and active. Even Cunningham's experiments seem to furnish warrant for this opinion. The cholera bacilli lived and were active in his cultures in unboiled milk during the winter in Calcutta, where, by the way, the thermometer rarely falls below 60° F. for a period considerably longer, as a rule, than during the spring, summer, and autumn.

Cunningham's previous experiments to determine the relation between the comma bacilli in the soil and the same germ in water, and the spread of cholera, which have appeared in earlier numbers of the *Scientific Memoirs by Medical Officers of the Army of India*, furnished him results somewhat similar to those relating to milk. He found that in non-sterilized earth, which normally contained swarms of various species of bacteria, the cholera bacilli soon succumbed in the active struggle for existence; whilst, on the contrary, they remained alive quite a long time and actively multiplied in soil which had been previously sterilized—*i. e.*, soil in which other species had been first killed by heat. The same was the case in his experience with boiled and unboiled water.

From all of these experiences Cunningham draws the general conclusion that, if the comma bacillus of Koch be the real cause of cholera, it very easily falls a prey to the bacteria with which it is associated naturally in the soil, water, and milk of India, and that therefore it is difficult to understand how the epidemics are spread by these means.

What I have already said in commenting upon this author's conclusions concerning the milk can be applied equally well to his objection to water as a medium of the spread of the



germs of cholera. For a short time the bacilli of Koch multiply in water which contains many other bacteria and even sometimes gain the ascendancy, although later they may be exterminated. If the water be used during this period I can not conceive why the comma bacilli, if they be the real cause of cholera, can not produce the disease under circumstances otherwise favorable for its generation. Likewise, I would apply the same reasoning to soil impregnated with the germs of cholera, although I myself believe that it is the water and the milk supply which are in the vast majority of cases responsible for the rapid spread of epidemics of this disease.

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#### OBSERVATIONS ON BACTERIA IN CHOLERA.

By Surgeon-Major G. BOMFORD, M. D., *Bengal Medical Service.\**

The following is a brief abstract of the results of microscopical examination of the tissues in nine cases of cholera which have died at the General Hospital, Calcutta, during the past twelve months (June 1886 to June 1887), showing, in each case, the duration of illness, the stage the disease had reached, the tissues examined, and the bacteria, if any, found. The patients were all adult European seamen, and the *post-mortem* examination was made in less than an hour after death in every case:

\* \* \* From this statement it will be seen that some portion of the intestine was examined in seven cases, and that in four of these no bacteria were found in the substance of the mucous membrane. In the three other cases bacteria were present in the depth of the mucous membrane, but they differed remarkably in character or distribution in each case. In No. 4, the bacilli were of large size, distinctly curved, and abundant; not only in the interior of the crypts of Liebekühn, but also on their exterior surface, and in the adenoid tissue surrounding them. They had also penetrated in many places below the muscularis mucosa into the submucous tissue. In No. 5, the bacilli were smaller and more curved, and in portions of the ileum from the neighborhood of the ileo-cæcal valve they were very abundant throughout the whole length of the cavity of the crypts, but there were none on the exterior of the crypts or in the adenoid tissue. In the spaces between the villi and on their free surfaces, as also, in most cases, just within the mouth of the crypt, the curved bacilli were more or less mixed with micrococci and minute straight forms, but in the deeper parts of the cavity they were almost pure. In the vessels of the submucous tissue there were a few minute micrococci. In the colon of the same case there were several slightly raised; smooth, deeply congested patches, in which the microscope showed the crypts had been completely destroyed and the whole depth of the mucous membrane infiltrated with leucocytes, blood-corpuscles, and peculiar filiform bacilli which were very numerous and penetrated down to the muscularis mucosæ, but not below it. These were very long and narrow, tapering to a fine point at either end, and stained faintly and unevenly along their length, so that they presented an irregular beaded appearance. They have some resemblance to forms described by writers as involuted cholera bacilli. In No. 9, only the vermiform appendix was examined, but in the crypts at its attached end there were numerous spirilla as well as detached curved bacilli.

In cases of secondary fever it is not uncommon to find the lower lobes of the lungs cedematous and presenting here and there small purulent foci. In No. 5 this condition was very marked, and sections through one of the abscesses, about the size of a walnut, showed numerous micrococci, generally in the form of a streptococcus of three or four beads, both within the vessels and amongst the pus corpuscles which filled the air-cells. The lungs in No. 9 were in a similar condition.

In No. 1 there were micrococci in the blood in the vessels and in extravasations amongst the tubes of the kidney. In five other cases a most careful search failed to show any bacteria in the kidney.

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\*Scientific Memoirs of Medical Officers of the Army of India, 1887.

In two cases, both of long duration and with marked secondary fever, there were ulcers in the stomach. In No. 6, there were two slightly raised deeply congested patches with smooth bare surfaces, in which, under the microscope, the glandular tissue appeared to be completely destroyed and infiltrated with leucocytes, blood-corpuscles, and numerous straight bacilli, some of which had a spotted appearance as in the next case. In this, No. 8, the ulcers were three in number of the ordinary form, with raised undermined edges and a necrosed slough in the center. The surface of the ulcer and of the mucous membrane near it was thickly covered with clusters of straight bacilli, which penetrated deeply into the mucous membrane and took the place of the epithelium. These bacilli were stained deeply at either end, and in the case of the longer ones at one or more points in the length, so that they had a spotted appearance as if they contained spores.

The following *methods* were employed: The tissues in all cases were removed as soon as possible from the body and placed at once in alcohol, and after hardening in this they were thoroughly infiltrated in paraffine and cut up with a Cambridge rocking microtome to enable the sections to be fixed upon a cover-glass with a solution of celloidin in clove oil (Schöllibaum's section-fixing process, *vide* Lee's *Vade Mecum*, section 275). The cover-glass is painted with the thinnest possible film of this solution, and after the sections in paraffine have been laid out upon it, warmed gently over a spirit-lamp or on a water-bath, so as to melt the paraffine and evaporate the clove-oil. By this means the sections are firmly fixed upon the glass, and it can be afterwards put through the staining processes in the same manner as an ordinary cover-glass preparation, the paraffine being removed by naphtha or other solvent. Any stain that the celloidin takes up is quickly removed by alcohol. For clearing clove-oil must generally be avoided, because it loosens the sections, and as a rule oil of origanum has been used, which has also the advantage of not dissolving out aniline stains. By this fixing process sections so friable as those of a lung infiltrated with pus can be easily stained and mounted without disturbance of the delicate tissues or loss of pus corpuscles, etc., while sections of the intestines can be laid out flat and untwisted with the sloughs, mucus, blood, and other corpuscles accurately *in situ*, and consequently can be more satisfactorily examined for bacteria than when freezing or other methods of making sections are adopted. Three, four, or even more sections, according to their size, and either consecutive or otherwise, can be fixed upon a large cover glass and thoroughly searched and compared. For staining the sections alkaline methyl-blue (Schütz or Löffler's solution) or a watery solution of Spiller's purple has been used, while in the case of the other tissues either these or some stain by the Gram method.

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#### REVIEW OF EXPERIMENTS CONCERNING ETIOLOGY AND PROPHYLAXIS OF CHOLERA.

M. BALLET of Paris (Vienna Congress of Hygiene and Demography, 1887) sketched briefly the investigations which had been conducted in France concerning the nature and pathogenesis of cholera. In 1885 Strauss and Roux, through their observations on cholera in Toulon, entirely confirmed the views of Koch. Doyen also found the constant presence in cholera of the comma bacillus, which, according to him, develops originally in the intestine but later effects a general micro-parasitic infection of the organism. In fact Doyen claims to have found the comma bacillus in the liver, in the kidneys, and in the spleen. Later Nicati and Rietsch succeeded in inducing cholera in animals by means of pure cultures of comma bacilli.

That the comma bacilli act by the secretion of a ptomaine, is made probable through the labors of Pouchet, Nicati, and Villiers.

On the other hand, Bouchard declares himself against the views of Koch. According to him, if these views be correct we should logically aim at intestinal antiseptics with certain doses of iodoform and naphthaline. Notwithstanding that he had produced this antiseptics in his cholera patients, he had a mortality of 60 per cent., whereby it is proven that the pathogenic agent of cholera is not located exclusively in the intestines. (The absurdity of this reasoning does not call for answer.) According to Bouchard, the cholera poison is not produced by the



comma bacillus. If one injects a pure culture of comma bacilli into a rabbit and later kills it, the appearances of cholera are never seen. This negative result is, however, no proof that rabbits have an immunity against cholera, for, if one injects into the vein of a rabbit the peculiarly toxic urine of a cholera patient, it will develop a series of symptoms very similar to cholera (cyanosis, cramp, hypothermia, diarrhoea). Bouchard therefore does not entirely deny a certain pathological significance to the comma bacilli, for the cholera poison may indeed be produced by the cells modified by the comma bacilli.

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*EXPERIENCE CONCERNING ETIOLOGY AND PROPHYLAXIS OF CHOLERA DURING THE LAST EPIDEMIC.*

HERR BABES of Budapest, (Vienna Congress of Hygiene and Demography, 1887,) remarked upon the experience concerning the etiology and prophylaxis of cholera during the epidemic of the last 4 years, with especial reference to the spread of the disease in Hungary.

He affirmed the etiological significance of the comma bacillus. In about 50 cases of cholera he found no other characteristic parasite than the Koch comma bacillus, whilst, moreover, he never was able to find it in cases which resembled cholera. The comma bacillus can be demonstrated with the microscope on the surface of the intestines, in the intestinal glands by means of cultures, also in the omentum in a few cases, by means of the same method in the kidneys also in a few cases. Other bacteria of the intestines may exceptionally be found in the internal organs during life, as, for example, the "Naples bacillus" of von Emmerich, which belongs to the class of saprogenous bacteria of the intestines. A spherical body related to the circular form of the cholera bacillus and behaving characteristically towards staining fluids may be found, which is located at the end or in the middle of the elongated bacillus, and possibly represents a rest form, like the arthrospore of Hüppe, and which appears to be a later stage of development of the body found by this observer. [Compare also researches of Ferrán—E. O. S.]

As to the behavior of the cholera bacilli towards other bacteria, it is demonstrated that especially the saprophitic bacteria act upon the gelatine and agar-agar in such a manner that in consequence thereof the comma bacilli develop only with difficulty therein. As regards the poisonous action of the cholera bacilli, this author could not convince himself of the presence of a characteristic ptomaine, at least he could not isolate one. Extracts obtained after the methods recommended for the separation of the ptomaines did not prove to be more poisonous than the culture fluid sterilized by heat at 80° C., which, injected even in small amounts into the circulation or under the skin, killed white mice, rats, and in greater quantity killed also guinea-pigs and rabbits.

As to the spread of the disease, it proceeded in almost every case from cholera patients and their effects, and was seldom caused by the effects of persons who were not sick. The direct proof of infection through the drinking water, it is true, could nowhere be brought out, yet the epidemic was often closely associated with bad drinking water. He was able in a few instances to find the comma bacilli upon the personal effects and the floor of the room of cholera patients. In the most carefully investigated cases the proof was obtained that not the water used for drinking and domestic purposes, but personal effects or food were the means of infection.

Fall of the barometer was in some instances followed by increase in the number of the sick, whilst other meteorological changes had no appreciable influence on the epidemic.

Immunity of places could not be demonstrated, but in numerous instances it was proven that the disease spared those places most exposed to danger; for example, the personnel of cholera hospitals, if the preventive measures suggested by the knowledge of the habits of the comma bacillus were promptly applied. By means of such preventive measures, if they be rationally carried out (which for the most part is dependent upon the intelligence of the inhabitants), localities can be very easily made immune. The epidemic itself was not milder than former ones; the narrowness of the outbreak was solely due to the employment of rational precautions and to the improvement in the mental status of the population.

Regarding the necessary prophylactic measures, it is of the highest importance—and it should be enforced by international convention—that the first cases be investigated from the stand-point of the comma bacillus of Koch by experts who have been specially instructed in this matter by investigators of recognized competency. The measures against the introduction and spread of cholera, published by Koch, Raubach, Riedel, Babes, and others must likewise be practiced, and by international concord introduced everywhere. Even the control, the execution, of these regulations should be handed over to an international commission. The unfortunate state of affairs in Budapest at the outbreak of cholera shows the importance of the last affirmation. It may be affirmed with certainty that the enforcement of these regulations would be capable of banishing cholera forever from Europe.

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*AN INQUIRY INTO THE CAUSATION OF ASIATIC CHOLERA IN SHANGHAI.*

By NEIL MACLEOD, M. D., Edin., and WALTER J. MILLES, F. R. C. S., Eng.

WITH EXPERIMENTS ON ANIMALS BY NEIL MACLEOD, M. D.\*

This inquiry was commenced in the end of 1884. Most of the conclusions arrived at in the first three parts of this paper were published in the health officer's report for 1885 to the Shanghai Municipal Council. Delay in finishing the report has been due to a variety of causes, amongst others the daily work of a large practice, the heaviest part of which is in the middle and end of the hot season, the period chosen by cholera for its ravages in Shanghai. Before this investigation was begun Koch had just published some of his results, and, as he was then almost the only worker in the bacteriological field of whom it could be said that he had not published anything subsequently upset, attention was therefore directed at once to the "comma bacillus." Powell and Lealand's half, quarter, eighth, oil twelfth inch [N. A. 1.43] and substage condenser were employed for microscopic examination. For separating the organism and furnishing characters of identification plate and tube cultivations in a slightly alkaline jelly prepared with the usual proportions of meat infusion, salt, peptone, galatine, and bicarbonate of soda were used. In order to keep the jelly in the solid condition during hot weather, plates and tubes had to be kept in an ice-chest, the temperature of which was never allowed to go above 75° F., and usually maintained between 60° and 70°. This difficulty of dealing with gelatine cultivations when the temperature is never below 80°, and often over 90° both day and night, practically caused the loss of the first season. Agar-agar plates were then tried and found useless for the purpose. Each investigator worked independently in a separate house, mostly with the same, but occasionally with different material, so that the majority of the cases were investigated by both.

PART I.

The first step in ascertaining the relationship of an organism to a disease is the determination of the characters of identification of that organism for purposes of future recognition. The fallacy of trusting to microscopic characters alone for this purpose has been well illustrated in the last 5 years' literature of Asiatic cholera. The axiom of bacteriological work for determining identity may be stated thus: The same organism grown under the same conditions as to medium, temperature, and time will have the same macroscopic, and if subjected to the same conditions as to staining, treatment in mounting, and examining, the same microscopic, characters. The characters of identification laid down by Koch for this organism are now accepted by all observers as sufficient, the name alone being altered. The "comma bacillus" is now regarded as a "spirillum." The characteristics are:

- (1) It occurs in the characteristic cholera stools.

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\*Lancet March 2, 1889.



(2) It is from one-half to two-thirds the length of the tubercle bacillus, somewhat thicker than the latter, and slightly curved. Sometimes the rods combine to form a half circle, an S-shaped curve, or a wavy line of varying length.

(3) It grows in, and liquefies, slightly alkaline gelatine; more slowly in neutral, scarcely at all in slightly, and not at all in markedly acid gelatine. On a gelatine plate cultivation the individual colonies are round, and lie in a funnel-shaped cavity; viewed by transmitted light and magnified, they look like ground glass, and the edge of the colony is finely notched. In a gelatine tube a funnel-shaped cavity forms at the top of the puncture made by the inoculating wire, and lying in this cavity what looks like an inverted air bubble with its top on a level with the surface of the jelly and open to the air; along the puncture the gelatine liquefies, and in this may be seen with the naked eye the whitish mass of colonies, more particularly at the lowest part; in from 3 to 4 weeks liquefaction spreads to the whole mass, the bacilli falling to the bottom as a greyish-white sediment having a faint orange tint in certain lights, and, if undisturbed, a perfectly transparent liquid separates a whitish scum on the top from the sediment below.

(4) A freezing temperature does not destroy it. It grows scarcely at all below 50°, slowly at 60°, rapidly from 80° to 100° F. in gelatine cultures. (For ordinary work these characters suffice for identification.)

(5) It is actively mobile in fluid media.

(6) Grown on agar-agar cultivations, it has no characteristic appearance, resembles many other organisms, and forms a brownish scum.

(7) On potato slices at a temperature of from 90° to 100° F. it forms glistening greyish-brown colonies, but does not grow at all at ordinary room temperature. (On certain kinds of potato there may be no brown coloration.)

(8) It liquefies blood-serum.

(9) Growth ceases in the absence of air in gelatine cultivations.

(10) Kept moist, it lives for months in pure tubes after growth has ceased; dried for a few hours it dies.

(11) It is reproduced by fission. Spores have not been observed.

Nearly all observers of this organism have described what are called involution forms. These are characterized by irregularities of shape, more particularly in their thickness, so that it requires reinoculation and growth under ordinary favorable conditions to determine that the specimens having these appearances are indeed pure cultivations of comma bacilli. Ceci and others have described certain spore-like appearances in involution forms, but these are now regarded as dying or dead parts of the rods, such parts staining very slightly or not at all. Hüppe has described what he regards as "lasting forms" and calls "arthrospores," as distinguished from "endospores." These he found in cultivations which were becoming exhausted of nutriment, and he examined only living and unstained specimens. [Hüppe has observed the development of his arthrospores under his eye in the field of the microscope in living cultures. Consult his paper on a previous page.—E. O. S.] If the drying test for spores is to be regarded as an absolute one, they are not spores. One of the authors of this inquiry found an appearance like that of endospore formation in actively growing neutral gelatine cultivations kept for three days at 70° F., clear, unstained, round or oval spots in stained bacilli, one in each rod, seen also in spirillum forms, and in slowly growing cultivations in involution forms. The appearance is that usually associated with the presence of spores, and hundreds are to be seen in a single field. After forty-eight hours' drying, growth took place but not after a longer interval. The nature of these spots has yet to be determined. For rapid examination of a fluid containing the organism, a thin film spread and dried on a cover glass can be stained by a watery solution of fuchsin in a few seconds, washed with water, and, while yet wet, explored with an oil immersion twelfth or objective of similar power.

## PART II.

The second part of the investigation, the occurrence of the organism in relation to the disease, was tested in forty-four cases. Of these, thirty were fatal, but only six could be examined after death, a number being Chinamen, whose bodies may not be examined after death except under pains and penalties of a severe kind. In forty cases the comma bacillus was found; in one, examined by both observers, there were numerous comma bacilli on the cover-glass preparation of the stool, but not a single colony could be found in the plate cultivations, the stool having been mixed with carbolic acid when collected. The three other failures were with non-characteristic stools, and amongst the early cases investigated. With a few exceptions, one drop either of a typical stool, or of the contents of the ileum during the collapse stage, was sufficient to furnish demonstration of the organism by cultivation, whilst the exceptions disappeared on the examination of a second drop. From such a stool recently passed, colonies were almost always present on the third plate which could only have contained about the one, three, or four-thousandth part of the original drop.

Later than the collapse stage, when the stool or bowel contents were no longer typical, but opaque, slimy, or faecal, the organism was rarely found, and then with difficulty. *Post mortem* examination alone is not sufficient to determine the absence of the organism from a given case, and must be supplemented by failure to find it in the typical stools during life. The conclusion arrived at by Drs. Roy, Brown, and Sherrington, that the organism is not present in every case of Asiatic cholera, appears to have been based on *post mortem* examinations alone. All who have seen many cases of this disease will recall those in which the collapse stage is followed by a stage where there may be little or no reaction, and the stools are no longer characteristic. Probably some of the cases examined by Roy, Brown, and Sherrington belonged to this class. Unless the cases were under their own observation during life, they could not be certain that they were dealing with those of the true collapse stage. The term "rice water" applied to stools does not give a true idea of the typical cholera stool. Rice water—that is water in which rice has been boiled—is non-transparent, and has finely granular matter dispersed through it on being shaken up; while the typical cholera stool is almost transparent or slightly opalescent when seen in a glass vessel, having no odor or but a faint meaty smell, and contains white flakes consisting of masses of epithelium, but which are not in sufficient quantity to render the fluid opaque. In all non-typical stools several different organisms were found, which were conspicuously absent from the typical stool, affording, as it frequently did, almost a pure cultivation of the comma bacillus when submitted to the test of plate cultivation. The presence of the organism in the intestinal follicles, which have their interior communicating with the lumen of the bowel, might be naturally expected where the organism is in large numbers in the bowel contents. This expectation was fulfilled in such cases, and follicles were to be seen crammed full of epithelial debris and comma bacilli. The organism was also seen in the spaces formed by the separation of the epithelium in the follicles and the basal membrane, and occasionally in the tissues near the follicles. The penetration of the bacilli into the follicles and these sub-epithelial spaces was no doubt the result of their own activity, but their demonstration in the tissues beyond was not sufficiently satisfactory to exclude their introduction into that region as the result of manipulation in cutting, etc. The process of staining sections of intestinal tissue for the demonstration of these organisms is not an easy one, and probably accounts for the failure to find them by so many observers. In specimens stained by Koch in Egypt, and very lately others stained by a new process of Kühne's, the presence of the comma bacilli in the tissue of the intestinal wall can not be doubted. Klein has arrived at the conclusion that, if they enter the tissue at all during life, it is only during the prolonged agony before death, but he does not advance sufficient proof for such a statement.

A sufficient number of necropsies were not made on which to base generalisations as to the appearance of the bowel, but the following notes of individual cases give a fair representation of what was met with. In a case where death took place 10 hours from the apparent onset of the disease, and the *post mortem* within half an hour of death, the small intestine



was distended and externally was rose-red, the wall having a lax appearance as if paralysed, or as if it had been over distended and had not recovered its contractile power. The contents were the clear fluid before referred to as "typical stool," the ileum being more particularly distended therewith. The mucous membrane was swollen, its epithelium stripped to a considerable extent, and the red spots marking the mouths of the follicles. On microscopic examination, many of these follicles were seen to be filled with broken-down epithelium, others with the epithelium detached from the underlying membrane, and the epithelium of the lumen of the bowel was absent in places. Comma bacilli were present in the follicles and subepithelial spaces. In a case of 30 hours' duration, examined 6½ hours after death, the small bowel presented a similar appearance to the foregoing, but was more deeply congested, there being hæmorrhages in the mucous membrane. Comma bacilli were present as in the last case. In a third case, 32 hours ill, examined 2½ hours after death, the ileum contained a thin, slightly blood-stained fluid, not in the least slimy or fæcal, there being intense congestion and swelling of the mucous lining, with much stripping of the epithelium. In a fourth case, where death took place on the fourth day, after very feeble reaction, and the stools had become slimey, dark brown, scanty, very offensive, and with a suspicion of a fæcal odour, the bowel contents were of the same character as the stools, but more manifestly blood-stained. Here stripping of the epithelium, ulceration, hæmorrhages, and everywhere great congestion, were the features in the small gut. The comma bacillus, which had been plentiful when the stools had been characteristic; were not to be seen in the follicles or the bowel contents, other organisms being abundant in the latter. Other organisms could be occasionally demonstrated in the intestinal wall, and in one instance a fine specimen of a fungus network deep in the tissues, probably a post mortem intruder. The sections were stained in Koch's solution of methylene blue for 24 hours at the ordinary temperature of the room.

So far as the question of the presence of the organism in the tissue of the intestinal wall is concerned, it has to be remembered that is not an easy thing to demonstrate; and even supposing that the bacillus does not penetrate the tissue of the wall in every case, the relationship of the organism to the disease is not necessarily thereby materially influenced. Klein and Gibbes, in the Government report of their cholera work in India, state that in certain cases they found but few organisms, and advance this as one of their reasons for not regarding the comma bacillus as the cause of the disease. When it is remembered that the stools are usually numerous and copious, no calculation as to the number of organisms present in a given case can be of any value, when such estimate is based on the examination of a few drops taken from a large and unknown quantity of the material voided from or retained in the bowel.

### PART III.

The third step of the investigation, the search for the comma bacillus in other than choleraic conditions of the human body, was carried out in 6 cases of diarrhoea, 1 of dysentery, specimens of saliva from 4 healthy subjects, scrapings from 3 diseased tonsils, 1 specimen of a healthy stool, material removed from the ileum of 2 cases of phthisis, 2 cases of malignant disease of the stomach, 1 case each of tubercular peritonitis and pneumonia, cerebellar disease, strangulated hernia, cardiac disease, tubercular meningitis, acute bronchitis, and empyema. In several of these, comma-shaped organisms were seen on microscopic examination, but never in any number, and in no single instance did cultivations on plates furnish such an organism. It has to be remembered that this material was subjected to the same process of examination as the cholera material, and also that there are few organisms more easily detected by plate cultivations than the comma bacillus. In a fluid containing comma bacilli alive, examination by plate cultivation will detect them when microscopic examination will fail to do so.

Other bacilli have been advanced from time to time as identical with the comma bacillus, but on closer acquaintance their claims have been set aside. Finkler and Prior's *cholera nostras* bacillus and Deneke's cheese bacillus are the only ones that have attracted attention, and it is not necessary at this time to give their characters under cultivation. The latest claims of this kind have been put forth by Klein in the following passage: "The bacilli which

occurs in the fluid of the mouth, and which are probably those observed by T. R. Lewis, *I think I have in two instances out of many succeeded in cultivating, and they appear to me to be in their manner of growth in nutritive gelatine strikingly similar to the choleraic comma bacilli. Lastly, one of the two species observed in some was found to grow in gelatine in the same manner as the choleraic comma bacilli*"\* (The italics are not in the original.)

It is not quite plain from the context whether Klein claims that these organisms are the same as Koch's comma bacillus or that they are identical as to the characters mentioned by him; in any case, those given are not sufficient to prove identity where a suspicion of doubt exists.

It has been repeatedly suggested by critics that the comma bacillus is not the cause but the result of the disease. Now, either that organism is in the body before the disease occurs or it is not. If it is not in the body before the disease occurs, it must either enter the body each time that the cholera poison does so or originate spontaneously in the intestine in each case of cholera. Practically, therefore, this objection can only imply that the organism is already an inhabitant of the human bowel, but that it requires the choleraic process to demonstrate its presence there, since no one has yet succeeded in doing so apart from the disease. This is an objection without an atom of proof, except the following experiment by Klein, and it is the only evidence advanced to prove that an analogous occurrence can be produced experimentally in animals. His own words are these: "That a pathological state of the intestine has a good deal to do with the multiplication of comma bacilli I have proved by direct experiment. In a monkey which had received the previous day a dose of castor-oil, and had diarrhoea therefrom, the abdomen was opened under the spray, a loop of the lower ileum, just above the ileo-cæcal valve, and about from 4 to 8 inches in length, was ligatured above and below, care being taken not to include in the ligatures the large vessels. With a Parvaz syringe a droplet of mucous was withdrawn from the interior of the loop, and on examination no comma bacilli could with certainty be discovered. With another syringe about 2 cubic centimeters of a saturated solution of magnesium sulphate was injected, the loop replaced, and the wound stitched up and dressed antiseptically, the whole operation being done under the spray.

"Immediately afterwards the animal received subcutaneously 1 gramme of chloral hydrate dissolved in 1 or 2 cubic centimeters of distilled water. Our animal was killed after 48 hours; on *post mortem* examination the ligature loop was found much injected, and its cavity filled with and distended by mucus, containing streaks of blood and numerous flakes. On microscopic examination these flakes contained, besides amorphous mucus and detached epithelial cells, longer or shorter straight thickish bacilli. There were present numerous comma bacilli, some single, others in dumb-bells. On microscopic comparison it was found that they were of the same character as the cholera comma bacilli, except that perhaps they looked a trifle smaller than those in the choleraic mucus flakes. Cultivations were made of them on six gelatine plates, and in one of these after three days there were no doubt a few colonies which corresponded with those of the choleraic comma bacilli; this was proved to be the case after two more days. Cultivations in gelatine tubes and in agar-agar tubes yielded growths indistinguishable from the cholera comma bacilli."

The object of this experiment is to show that in the monkey's ileum a comma bacillus was present, but could not be demonstrated before a pathological state had been set up, after which it was found without difficulty. This is meant to be analogous to the failure of all observers to find Koch's organism in the normal human ileum, and the easy demonstration of its presence there in the collapse stage of Asiatic cholera. Unfortunately for the analogy, Klein does not show that this organism could not be found before the pathological state was set up in the ileum of the monkey, for he omitted examination by cultivation, the method most to be relied on for detection when few organisms are present, and without which identification is impossible. He examined microscopically alone, and, moreover, only one droplet. Further, had he employed both methods and failed to find the organism he was looking for, there would still remain the fatal objection to the experiment that there appears to have been no sterilization of

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\* Practitioner, March, 1887, p. 182.



the syringes used or of the needles and sulphate of magnesium solution introduced into the intestinal loop where later the comma bacilli were found. This sterilization precaution was an indispensable detail in an otherwise minutely detailed experiment.

Turning from the experimental to the logical method employed, the argument runs thus: Before the ileum of a monkey was brought into a pathological state no comma bacilli were found; after that pathological state was produced comma bacilli were found in large numbers; therefore, Klein goes on to say: "I conclude from the above successful experiment that, owing to the pathological state set up, the comma bacilli, *no doubt present already before the operation, but in far too few examples to be recognized in the microscopic specimens*, had so rapidly multiplied that their demonstration was then comparatively easy." (The italics are not in the original.)

To say the least of this argument, a more logical conclusion would have been that their multiplication was an example of spontaneous generation. The expression, "no doubt present already before the operation," is a fine specimen of that class of assumption commonly termed unwarrantable. Here, again, it is not quite clear whether Klein claims that he was dealing with Koch's organism, or with one identical only as to the characters given. The experiment just referred to is in itself scarcely worthy of the space devoted to it here. Its insertion is due to the importance its author has attached to it since it first appeared in the British Medical Journal where, applying it to the cholera question, he says: "It is evident from this that the pathogenic state of the intestine produced the condition favorable for the multiplication of the comma bacilli, and they are therefore the *result* and not the cause of the disease." Two years later it again appears in a long cholera article in the Practitioner, but with more detail. It is the only detailed experiment furnished by Klein upon which it is possible to form a judgment of his experimental method when dealing with this cholera question, another reason for the length at which it is quoted, and the consideration it has received.

#### PART IV.

*The reproduction of the disease.*—If Koch's comma bacillus be the cause of Asiatic cholera, and the disease be capable of transmission to a lower animal, on pure cultures of the living comma bacillus being introduced into the small intestine of a lower animal, growth and multiplication of the organism in the small gut must be associated with the signs requisite for the recognition of the disease in man, and it must be shown that the means by which the organism was introduced into the bowel do not of themselves produce such signs of the disease.

In Shanghai two sets of experiments resulted in failure, and for want of time further work of the kind was put off till the opportunity afforded by a holiday in Europe presented itself. The responsibility for this part of the work is not, therefore, shared in by both observers. While the early part of Koch's work was deemed of sufficient importance to be examined into by several British workers, and all these, with the exception of Drs. Roy, Brown, and Sherrington, have practically confirmed Koch's facts up to the point of reproduction of the disease, in this country Klein and Watson Cheyne alone have experimentally examined Koch's claim of having reproduced the disease as set forth at the second Berlin Congress of 1885, while several have been content to criticise. Watson Cheyne confirms Koch's results after Nicati and Rietsch's method, but does not appear to have made experiments after Koch's own methods. Klein allows that Koch's bacillus is pathogenic to guinea-pigs, but opposes the conclusion drawn as to its relationship to Asiatic cholera.

In two leading articles of "Nature" for July 10th and 17th, 1884, Klein, with no uncertain sound, declared his opinion against Koch's conclusion before he had made a personal acquaintance with the facts, and before he was appointed by the British Government to inquire into the relationship of the organism to the disease. It is to be regretted that he proceeded to India later in the year, having such a position to defend or evacuate. Perhaps no one has done more than Klein in connection with this part of the cholera question, and certainly no one in this country has more materially influenced British scientific opinion. Frequent reference is therefore here made to his work.

At the present time the general medical opinion in England as to the relationship of the comma bacillus to Asiatic cholera may be stated thus : The organism is found as a constant concomitant of the collapse stage of Asiatic cholera in Europe, Egypt, India, etc.; it has not been found apart from the disease; it occurs in that part of the body specifically affected—viz., the intestinal canal—and disappears from it with the disease; while it may be regarded as pathogenic, it has yet to be proved to be the cause of the disease.

Many workers having failed to reproduce the disease, Nicati and Rietsch, believing that Koch's organism given by the mouth did not reach the intestine alive, opened the abdominal cavity of dogs and injected cultivations of the bacillus into the duodenum, both with and without ligation of the bile duct. Under these conditions they believed that they reproduced the disease. Van Ermengem, Koch, Watson Cheyne, and others repeated those experiments with the same results, but the method has not been regarded as satisfactory for several reasons.

*Koch's experiments with guinea-pigs.*—At the second Berlin Congress, in 1885, Koch announced that he had succeeded in reproducing the disease in guinea-pigs without opening the abdomen. Finding the reaction of the contents of the guinea-pig's stomach always strongly acid, he neutralized this reaction by injecting into the stomach a solution of soda. He then found that, though the organism was thus enabled to pass through the stomach alive, no disturbance followed its presence in the small intestine. Many experiments of this kind failed. Only one animal became sick and died with signs like those of cholera, and this animal had aborted shortly before the experiment. In this case it was observed that there was some degree of peritonitis present as one of the results of the abortion. Koch then made some experiments to observe the conditions of the animal's digestion, more especially in the small intestine, and he found that its contents passed through that part of the gut in a very short period. Colored foods were seen to pass from the stomach to the cæcum in a few minutes. It occurred to him that, as in Nicati and Rietsch's experiments, the more the bowel was handled the more successful they were, and, *vice versa*, their success might be due to the lessening of the peristaltic action of the gut in consequence of the handling. The success in the guinea-pig that had aborted and in which peritonitis was present (a condition, too, accompanied by interference with peristalsis) suggested the same explanation—viz., that the normal peristalsis in this animal did not afford sufficient time for the multiplication of the organisms, so that they and their products might be hurried through the small gut before they had multiplied to the extent necessary to set up the changes constituting the disease, and from the acid reaction of the contents of the cæcum they were unable to multiply and do mischief in that part of the bowel. Recognizing in opium a drug that would lessen peristaltic action, he made experiments with it, and finally decided that the injection of opium tincture into the peritoneal cavity was the surest means of bringing about this loss of peristalsis without otherwise injuring the animal.

*Examination of the objections urged against Koch's experiments.*—In this way Koch claims that he has reproduced the disease, but his experiments are not yet regarded in England as sufficient, and the objections urged are : (1) The symptoms produced in the guinea-pig are not those of cholera in man, there being no purging, vomiting, or cramps. There seems to be little doubt that Pasteur has produced hydrophobia both in dogs and rabbits by material taken from the disease in man, but there seems to be as little doubt that the symptoms of that disease in man, the dog, and the rabbit do not correspond in any two out of the three. Is it to be expected that cholera in the guinea-pig will present the same symptoms as in man? Will anyone maintain that a given case in man, without vomiting, purging, or cramps, is not one of Asiatic cholera? Such cases are certainly met with in man, and what is the exception in man may be the rule in the guinea-pig. (2) It is objected that death and the *post-mortem* appearances in the animals experimented with may be the result of some other cause than cholera. There is some truth in this objection, as animals may die, for instance, from mechanical injuries with the catheter used to inject the stomach, from the injection of fluid into the wind-pipe, from needle injuries in the abdomen, from an overdose of opium, or from peritonitis



or septicæmia. Animals dying from such causes, and even those in which the injury might not be regarded as of itself sufficient to cause death, have been rejected from the experiments recorded in this paper. Such accidents might have been passed over without comment, but in the interests of any one repeating the experiments, it seems wiser to give the details by which they may be avoided, and the needless sacrifice of animals thereby entailed. With the indications afforded by a pharynx dissected for the purpose, the use of an English No. 3 catheter without the stilette, a wooden gag with a hole in it for the catheter and notched to receive the upper and lower incisors, the avoidance of force, and the exercise of a little patience, the passage of the catheter into the stomach of a guinea-pig is attended with as little injury as its introduction into the human bladder in careful hands. The entrance of the instrument into the trachea may be recognized by the character of the breathing and the shorter distance to which it passes without resistance, as contrasted with the œsophagus. If fluid be injected into the trachea, the animal dies in a few minutes.

In the early part of the investigation a number of animals had to be rejected, as they died without awakening from the opium sleep, after receiving the dose recommended by Koch, viz, 1 cubic centimeter of the tincture of opium to 200 grammes of the animal's weight. A series of cases was tried with smaller doses, and finally it was determined to measure the dose in each case by the effect on the voluntary muscular system. Repeated doses of 1 cubic centimeter, or less, were injected till the animal was sufficiently stupified to lie on the side or back for at least ten minutes when placed in that position. Several times the dose recommended by Koch had to be given, but usually a smaller one sufficed. After adopting this method no deaths occurred attributable to opium. Of the first seven animals receiving tincture of opium alone, injected with a Pravaz syringe disinfected by means of sublimate solution, and that only before the first injection, two animals died on the afternoon of the second day, having been lively that morning. These deaths were attributed to septicæmia, as no special injury could be detected, and none of fourteen opium-control animals died that were subsequently injected with a Koch syringe, the needle of which was heated red in the Bunsen flame, and then allowed to cool before each injection, and the glass sterilized in the hot box. Koch's syringe, having no piston, is more easily sterilized than the Pravaz syringe.

When the needle enters the peritoneal cavity, or when it is already there and the animal struggles, the bowel or a blood vessel may be injured, but this seldom occurs if the animal be held with its back in the left palm, the front abdominal wall being projected forwards and made tense by the thumb and fingers on each side, when it is easy to just enter the peritoneal cavity with the needle point. An assistant should hold the fore and hind quarters. All vessels with which the needle and syringe came in contact as well as those that contained laudanum and fluids to be injected, were sterilized in the hot box before being used.

Of 142 experiments which were made, some were carried out at the Royal College of Physicians' new laboratory for research in Edinburgh, but owing to the restriction of the number of the experiments in the terms of the vivisection license, and delays in extending or renewing the latter, the others were done at the Hygienic Institute at Berlin. The organism used was taken from the stools of a case of Asiatic cholera in Shanghai in October, 1887, pure cultivations being made from plates, and fresh gelatine tubes being inoculated at intervals of from three to six weeks. The organism retained its virulence, so far as guinea-pigs are concerned, until the following October.

*Control examination of intestine of healthy guinea-pigs.*—Thirteen healthy guinea-pigs were killed, and the contents of the ileum examined both microscopically and by means of cultivations on plates. Normally, the small intestine was almost empty and contracted. Occasionally a little food could be seen in it, but it was never distended as it is after an animal has been injected with opium as described, in which case the contents were very similar to those of the stomach. In no instance was there any organism obtained by cultivation of the material taken from the ileum that could be called comma-shaped, though the microscopic examination sometimes furnished such forms in small numbers, as well as spirilla and large, curved, worm-like organisms, the latter being very numerous in the cæcal contents. An

interesting observation was made on the contents of the ileum after death when opium alone had been given. Plate cultivations from these presented an appearance contrasting markedly with plates charged with the ileum contents of animals that had not had opium, the former containing in every plate large numbers of an organism not observed in the latter.

In the experiments presently to be described all animals injected with cholera material, as well as those used for control experiments, were treated in the same way, viz, without any preliminary starvation; 5 cubic centimeters of a 5 per cent. solution of soda ( $\text{Na}_2\text{CO}_3$ ) were first injected into the stomach by means of the catheter, and from ten to twenty minutes later a quantity of the cholera material or sterilized broth was similarly injected. Immediately thereafter the opium tincture was introduced into the peritoneal cavity in the quantity and with the precautions before described.

*The effect of opium on intestinal peristalsis.*—The strongly acid reaction of the normal contents of the guinea-pig's stomach is neutralized by the soda injection, the reaction sometimes remaining neutral for six hours. The opium injection prevents the too rapid passage of the organism through the small intestine, thereby affording opportunity for its multiplication. Koch states that the injection of alcohol is attended by a similar effect on peristaltic movement. Klein admits the multiplication of the organism, but denies that there is interference with the peristalsis, of which he says: "It is not proved that injection of tincture of opium into the peritoneal cavity produces relaxation of the intestine and arrest of peristaltic movement; there is no proof given for this by Koch as regards the guinea-pig; on the contrary, there are experiments on record made on the dog, where the result of such injection was quickening of the peristaltic movement."\* The effect quoted as regards the dog may have been the result of a small dose. No reference is given by Klein to his authority, so that it is not possible to determine the dose given to the dog. Klein seems to have forgotten for the moment that both alcohol and opium, when acting on nerve centers, stimulate in small doses, depress, and even arrest altogether, their actions, if the dose be large enough. Four guinea-pigs were injected, two with tincture of opium and two with rectified spirit, into the peritoneal cavity, in repeated doses till the animals were sufficiently stupefied to lie on the side when placed in that position. Two cubic centimeters of spirit were used in one case, and 2.75 cubic centimeters in the other, their weights being, respectively, 730 and 750 grammes. They were killed at intervals of from 6 to 9 hours afterwards, when "relaxation of the intestine and arrest of the peristaltic movement" were amply demonstrated in all four by distension of the small intestine with food to a degree never seen in health. In the animals that received the spirit the stupefaction lasted longer, and there was increased vascularity of both peritoneal and pleural serous membranes resembling that present in the conjunctiva, while in the opium-treated animals this was not a feature.

If Klein had made this experiment, which he charged Koch with omitting, he would not have placed himself in such a false position. He would also have escaped another; for, in discussing this peristalsis question, he goes on to suggest that the gut, instead of being acted on in this way, is brought into "a diseased state" by the tincture of opium in the peritoneal cavity, and that the poison produced by the bacillus can then act and kill the animals. In support of this he performed thirty experiments with opium given in other ways, and injected into the stomach certain cultivations which, he writes, "were of comma bacilli of recent broth culture or of gelatine culture, and were beyond question or doubt the choleraic comma bacilli."† All these animals recovered, and the recovery he attributes to the absence of "the diseased state" of the gut, no opium tincture having been injected into the peritoneal cavity. But the animals may not have been stupefied, *i. e.*, peristalsis may not have been arrested; or the recoveries may have been due to the attenuation of virulence of the comma bacilli used, since he omitted to place "beyond question or doubt" their virulence at the time of these thirty experiments by making control experiments with them under Koch's conditions and thereby producing death. Moreover, he gives no details of these thirty experiments as to doses, age of cultivations, or conditions of administration, so that it is not possible to estimate their value in other ways.

\* Practitioner, 1887, March, p. 199.

† Loc. cit.



*Dose of opium necessary to lessen intestinal peristalsis.*—It would appear that it is necessary to inject sufficient opium tincture to cause the animal to lie on the side or back when placed in that position; since, of animals receiving cholera material in doses sufficient to kill 60 per cent., of nine that did not receive sufficient opium to cause the animals to lie on the side when placed there only one died, while of fifty-four that were stupefied sufficiently to maintain the position on the side thirty-eight died. This degree of narcosis may not be a necessary element in the interference with the intestinal peristalsis, but such a degree of narcotic effect was demonstrated to be accompanied by a well-marked degree of loss of peristalsis. Interference with peristalsis being insufficient in degree when large doses of the cholera organism are present, or insufficient in duration with small doses, the escape of certain of the animals that were sick may be accounted for by the organism and its products being passed on to the cæcum with its products before it had multiplied sufficiently to set up the changes necessary for a fatal result.

*Cholera experiments with cultivations.*—In seven cholera experiments varying quantities of a gelatine tube cultivation of comma bacilli were added to 5 cubic centimeters of sterilized broth and injected into the animal's stomach. In the next twenty-seven experiments, a tube containing about 5 cubic centimeters of slightly alkaline sterilized broth was inoculated from a gelatine cultivation of the bacilli and incubated at 98° F. for twenty-four or more hours, and varying quantities of this were injected. Of these animals twenty-one died and thirteen recovered. The twenty-one animals recovered from the effect of the opium, sat up, and ran about, and those that had had small doses of the cholera material took food. On the following day they became sick, refused food, the coat stared, the edges of the eyelids became dry and gummy, and the hind legs were dragged, later becoming as if paralyzed; some animals died on the second day, and others on the third or fourth.

*Control experiments.*—Of eleven control animals treated in the same way, but receiving sterilized bouillon instead of cholera broth, all recovered. Three animals, after injection into the stomach of soda solution alone, seemed in no way affected.

*Cholera experiments with bowel contents.*—From one of the animals that died after a dose of cholera material the small gut contents were collected in a sterilized vessel and injected in doses of 2 cubic centimeters into the stomachs of two other animals. These two animals died, and the contents of their small intestine were used in the same way, and so on through ten generations. Of twenty-one animals so treated, two recovered, nineteen died. The dose varied in the later generations between .5 and 2.5 cubic centimeters.

*Control experiments.*—As control experiments to these, two animals received 5 cubic centimeters of the soda solution, 5 cubic centimeters of sterilized broth, and thereafter the usual dose of opium tincture. After six hours these animals were killed, and the contents of the small intestine collected and injected in doses of 2 cubic centimeters, and with the same precautions as the cholera material. Of four other animals thus treated, all recovered.

*Experiments with cæcal contents.*—The cæcum of the cholera-infected guinea-pigs was usually distended with watery and (if the animal had died early) greenish contents, and contained comma bacilli in great numbers among a multitude of other forms. From an animal where this was the case 2 cubic centimeters of the contents of the *ileum* were injected into the stomach of one animal, and a similar quantity of the contents of the *cæcum* into that of each of three animals, after the usual soda injection of the stomach, opium tincture being given later. The former died; the three latter recovered without a sign of sickness. Unfortunately no plate cultivations were made of these cæcal contents to ascertain whether the comma bacilli seen were capable of growth like those of the *ileum*. Koch's contention that these organisms are killed in the cæcum of these animals is so far borne out by these three experiments.

Of the fifteen animals that recovered after injection of cholera material, seven were manifestly sick, two were slightly so, and six were not apparently affected. At the present time even Koch's most energetic opponent, Klein, will allow that the proof of Asiatic cholera in man is the presence of the comma bacillus either in the stools of a person taken suddenly ill, with or without vomiting or cramps, or, if there has been no purging, in the contents of the

more or less distended, congested, rose-red, and paralyzed-looking small intestine, these contents being watery and containing white flakes. If these appearances were present in man after having been dosed with a pure cultivation of comma bacilli, in a country where no cholera was about, would they not be accepted as proof of the presence of Asiatic cholera, even after doses of soda solution and opium, as in the guinea-pig? If this test is to be accepted in man, why is it not to be accepted in the guinea-pig?

*Post-mortem appearances in the guinea-pig.*—On *post mortem* examination of these animals so dosed with comma bacilli, where death followed as described, the blood was fluid, thicker and darker than natural; the tissues of the thoracic and abdominal walls were markedly dry; the small intestine was throughout distended, congested, paralyzed-looking, and occupied a much larger proportion of the abdominal cavity than usual; and the cæcum was distended with fluid or semi-fluid contents. If the animal had died early, the fluid was not quite clear in the small gut, there being present traces of food; still the watery character was very manifest, and mucous flakes were abundant. If the animal died on the second or third day, no food remains were to be seen, and the fluid in the small gut was the counterpart of the typical cholera stool in man. In either case, the comma bacilli were demonstrated microscopically and by cultivation, as in man. While the organism in the broth injected could be frequently counted in a microscopic field, in a drop of the small bowel contents from an animal having received such broth the bacilli might be so numerous that counting, without dilution of the fluid examined, was an impossibility. On floating the bowel in water the stripping of the epithelium could be well demonstrated. Two animals not included amongst those already mentioned, died on the fifth and eighth days, respectively, after injection of cholera material. In these no trace of comma bacilli could be found. From the appearance of the bowel it might be inferred that they had died in the reaction stage. In one case, that of death on the eighth day, and the only animal that had had loose stools, the intestine was lax, congested, the epithelial lining extensively stripped, and Peyer's patches could be seen standing out prominently and ulcerated.

*Doses of cultivations and effects.*—While 2 cubic centimeters of cholera small gut contents was a deadly dose, the same quantity of cholera broth derived from the original cultivation as described was by no means so deadly. This might be due either to the greater number of the organism in the bowel contents or to its increased virulence after passage through the animal. The organisms were certainly more numerous in the bowel contents than in the broths injected. As plate cultivations were made from the former and broth cultivations grown from these as nearly as possible under the same conditions as to quantity inoculated, time and temperature in the incubator, the following experiments are worthy of record, though they were not made with the intention of comparing the relative virulence of the cultivations, and the quantities injected are not very suitable for comparison. Broth cultivations derived from the original cultivations brought from China, and therefore cultivated in gelatine for a year after being taken from the human stool, in doses of 5 cubic centimeters killed 5 out of 7 animals; 2 cubic centimeters killed 0 out of 4 animals; 1 cubic centimeter killed 1 out of 3 animals. Similar cultivations of bacilli which had passed through three generations of the guinea-pig, reckoning the first generation the first animal inoculated with bowel contents, in doses of 3 cubic centimeters killed 4 out of 4 animals; 2.5 cubic centimeters killed 1 out of 2 animals; 2 cubic centimeters killed 0 out of 2 animals. Similar organisms passed through six generations, in doses of 2 cubic centimeters, killed 3 out of 5 animals.

*Attenuation of virulence.*—Koch states that the organism obtained during the last European outbreak of cholera and kept under cultivation in his laboratory has lost its virulence so far as guinea-pigs are concerned, so that his former results are no longer attainable. In the guinea-pig, the larger the dose of cholera material given, the earlier the onset of sickness and death, so that the latter may take place within 24 hours of the time of infection.

*Objections examined.*—Klein and Gibbes, in rejecting Koch's conclusion that the comma bacillus is the cause of Asiatic cholera, at page 32 of the Government report of their investigation in India, embody their strongest reason for this rejection in the following words: "The



strongest reason for not admitting this kind of bacillar relation to the disease is this, that no bacilli exist in the blood or any other tissue of patients suffering from cholera." As the first manifestations of the disease are in the alimentary canal, and are usually very marked and followed by general constitutional disturbance, and as also after death the most marked departure from the normal condition is to be seen in the small intestine and its contents, this determination that the bacillus must be present in the blood or elsewhere, if it is to be the cause of the disease, is somewhat difficult to understand. On similar grounds Klein ought to deny that the pathogenic condition in the guinea-pig has any bacillar relation to the organism introduced into the alimentary canal of these animals, but when criticising Koch's results\* he admits that the organism is pathogenic to guinea-pigs, though they act from the intestine and are not found in the blood or elsewhere, so that this "strongest reason for not admitting this kind of bacillar relation to the disease" he applies to man but not to the lower animals.

Another and similar objection of Klein's runs thus: "If, as many believe, the cholera dejecta *per se* were possessed of infective power, then it would be quite impossible to understand how it happens that the attendants, nurses, and physicians of cholera patients, those who handle the cholera dejecta, and the friends and relatives living in the same room remain so often exempt.†

The fact that doctors, nurses, etc., in attendance on cholera patients are not specially subject to the disease, whilst it points to the inference that the cholera poison is not usually transmitted from person to person under these circumstances, by no means proves that such transmission can not take place. The contagious nature of the syphilitic poison, which is seldom transmitted to those in attendance, teaches so much, yet there can not be a doubt but that poison passes from person to person. It is not usual to carry the contents of the intestine directly to the mouth; hence probably one of the reasons why those in attendance on the cholera sick do not suffer more than others. A little light on this question is perhaps furnished by the following occurrence: Dr. Bentley, acting health officer at Singapore 5 years ago, was called upon to deal with an outbreak of cholera at Telak Blanga, near the Peninsular and Oriental Company's wharf. The disease was believed to have been introduced from India by one of the steamers which land native and other passengers almost every week, but for some time no light could be thrown on the continuance of the outbreak. The cases were observed to occur in groups of two following each other at intervals of about 2 days, and on inquiry it was elicited that these were persons who had washed the bodies of the cholera dead. The washing of the dead is an important Mohammedan rite, usually carried out with great care. Pressure was brought to bear upon the people to make them cease this habit for a time but without result, until an edict was obtained from the Sultan of Johore for this purpose, and the high priest gave his sanction to the omission of the rite. When this was done no more cases of cholera occurred. Here the multiplication of the organism in the discharges on the skin about the anus and in the loin cloth would be very rapid at the Singapore temperature. The frequently observed occurrence of the disease amongst those washing the clothes of the cholera sick is an incident of somewhat similar character. Both are in keeping with the remarkable multiplication of the organism as seen on linen stained with cholera stools and kept under observation in the laboratory. The exemption from the disease on the part of the attendants, etc., and its incidence as described amongst the washers of bodies and clothes suggest the explanation that in the fresh stools, or the quantities of them likely to be carried to the mouths of attendants directly, the dose, or, rather, number, of the organisms may be too small to set up the disease, while the larger number after multiplication outside the body may account for the greater risk to the washers, more particularly in hot climates and seasons. Klein demands that "in all bacteriological inquiries referring to infectious diseases the results of such inquiries, if they are to be accepted as well established, must be in harmony with the well-founded facts discovered by epidemiology," adding: "Now, I maintain with Pettenkofer that some important facts of our knowledge concerning comma bacilli do not harmonize with

\*Practitioner, March, 1887, p. 200.

† Ibid, April, 1887, p. 276.

well-established epidemiological facts.”\* The just application of this test will depend on what he means as regards “some important facts of our knowledge concerning comma bacilli.” It is somewhat puzzling to find him applying the test, and in consequence saying that it is impossible to believe that the disease could not have failed, as it did on certain occasions cited by him, or that epidemics could have ceased when they did, if the comma bacillus were the cause of the disease, since, to quote his own words, “the comma bacilli live and thrive wherever and whenever there is nitrogenous material; in fact, they are in this respect conspicuous by their small selective power. They grow in all localities, in all climates, and in all seasons.”† Is it possible that all nitrogenous material, all localities, all climates, and all seasons afford a suitable soil, suitable reaction, suitable temperature, and moisture, *without any one of which* growth and multiplication of the comma bacillus is impossible, which he himself sets forth as “important facts” relating to that organism in an exhaustive and excellent account of it?‡ It may be asked of Klein, if the organism grows, as he says, in all localities, climates, and seasons, wherever and whenever nitrogenous material is present, *why has he not been able to find it?*

Pettenkofer believes that the poison of cholera is discharged in the stools, and that it is an organized one, capable of multiplying outside the body; and, though these conditions are fulfilled by the comma bacillus, he expressed the opinion at the Second Berlin Congress, in 1885, that that organism could not be the cause of cholera, since it is so easily destroyed by drying, and there appears to be no lasting form or spore to bridge over this difficulty. He had in his mind the problem of epidemic occurrence in relation to the multiplication of the poison in the soil above the ground water-level. Below that level the soil is certainly wet; but above it it can not be said to be dry, except in a very loose sense, as is frequently seen in the moist condition of pieces of paper, cloth, etc., dug out of the soil above ground water-level. As regards the destruction of Koch's organism by drying, it has to be remembered that the drying process has been tested in air alone and that only on complete withdrawal of moisture does it die. With the exception of sand, under ordinary circumstances desiccation of the organism would be almost if not quite impossible in any soil except on the very surface. Thus death of the organism dried in the air accords with the almost universal belief in the non-propagation of the disease by the air, and does not interfere, as Pettenkofer thought, with the part played by the soil in the occurrence of epidemics. Pettenkofer also thought that because Emmerich's bacillus had been found in the blood and certain of the organs in some cases of cholera, and produced symptoms in the guinea-pig like those of cholera, it might with more justice be considered the cause of the disease. He also suggested that Koch's organism might be normally present in man and multiplied in consequence of the disease. Emmerich's bacillus has since been found in the normal stools and in the air and elsewhere, and in the symptoms referred to are produced in common by a number of other ptomaine-producing organisms. Again, easy destruction of the comma bacillus by decomposing organisms has been regarded by Klein and others as a further objection, as they think the bacillus could not multiply in the presence of filth and filthy habits, which all authorities regard as factors in the spread of the disease. The conditions of survival of the organism under domestication in the laboratory doubtless throw some light on the struggle for existence in the natural state, but the confinement of the contest between the comma bacillus and other organisms within the limits of test-tube and plate cultivations can not be regarded as representing the limits of the struggle amongst natural filth and filthy habits, any more than the contest and its results between cats and mice in a room represent the struggle in nature and the result as to the survival of mice.

Nearly all observers are agreed that for the spread of the disease and the production of epidemics there must be a local disposition and one of season.§ While some regard these as simply conditions favoring the multiplication of the poison outside the body and its distribution, others, according to Pettenkofer's hypothesis, think that the poison fresh from the stool is only capable of causing isolated cases of cholera, and can not cause epidemics until the

\* Practitioner, April, 1887, p. 272.

† Ibid., Jan., 1887, pp. 6-19.

‡ Ibid., p. 275.

§ Ortliche und Zeitliche Disposition.



poison has undergone some change outside the body. Koch's organism is certainly capable of multiplication outside the body, but whether such a change in it is necessary as is demanded by Pettenkofer's hypothesis can only be settled by a knowledge of its life history in relation to the production of epidemics, a branch of the subject as yet unexplored.

*Summary of conclusions.*—(1) The comma bacillus of Koch is invariably present and associated with certain changes in the small intestine in cases of Asiatic cholera. (2) There is no evidence to show that it is a normal inhabitant of the human alimentary canal, and therefore no proof for the assertion that it is a result of the disease. (3) The means used to introduce the comma bacillus into, and those to lessen the peristalsis of, the small intestine of the guinea-pig can not be regarded as causing appearances like those of Asiatic cholera or as causing the death of the animal, far less a mortality of over 60 per cent. (4) Pure cultivations of the comma bacillus introduced into the stomach under the precautions described are pathogenic to the guinea-pig. (5) Injected with similar precautions, the contents of the ileum from those animals killed by injection of pure cultivations of the bacilli act in the same manner as pure cultivations of that organism. (6) The organism multiplies in the small intestine of the animal, and there are therewith associated changes similar to those in man in Asiatic cholera. (7) There is strong evidence, therefore, for regarding the comma bacillus of Koch as the cause of Asiatic cholera.

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#### CONCERNING A BACILLUS IN THE INTESTINE OF CHOLERA.

By PROF. SCHRÖN, of Naples.\*

The author showed preparations which he thought demonstrated his so-called "cholera brood capsules;" and he believed that the bacillus observed by him in the intestines of cholera patients had some points of similarity with the comma bacillus of Koch. The author asserts that the bacillus demonstrated by him is very numerous during the cholera process in the intestines. Two years ago Schrön had observed all the phases of the development of this bacillus in hardened and stained sections of the intestinal wall. He succeeded this year for the first time in demonstrating in sealed hanging-drop gelatine cultures the characteristic cocci and bacilli capsules which are formed from the bacilli (not from spores) and in following them through all their stages of development.

Schrön regards as important the circumstance that the micro-organism in question selects for its development the connective tissue, a collagenous substance, as also for the production of the characteristic capsule a fluid which more nearly resembling serum than gelatine (*e. g.*, Koch's beef bouillon).

The author adds conclusions affirming the general invasion of the body through the broods of the bacillus. According to him the extensive distribution of cocci (to which the forms extruded from the "*utricles*" or brood capsule have the greatest resemblance) and the enormous accumulation of the same in the perivascular lymph spaces of the central nervous system, as well as in the tissue of the kidneys, liver, and lungs, make the close relation of these elements with the demonstrated bacillus probable, and render it impossible to deny that the dreaded ptomaine may be formed at the points of the accumulation of the cocci; for example, in the tissue itself. Finally, he believes it is hypothetically reasonable that these organisms stand in genetic relation with the cholera process.

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\*Tageblatt der 59. Versammlung deutscher Naturforscher und Aerzte zu Berlin, 1886. Baumgarten's Jahresbericht, zweiter Jahrgang.





## ILLUSTRATION, No. 15.

FIG. 1. Comma bacilli in stools.

FIG. 2. Comma bacilli from gelatine cultures.

FIG. 3. Comma bacilli from bouillon cultures; long intertwined forms and fine spirilli.

FIG. 4, 5, and 6. A series from bouillon cultures; the spirilli assume a wave-like form.

FIG. 7 and 8. Forms whose significance we do not know, perhaps antheridiæ.

FIG. 9, 10, 11. Forms from the fluid squeezed out through an incision at the point of inoculation: 11 wrinkled blood corpuscles; 10 fat-like discs of different sizes; 9 images, concerning whose origin and significance we have no opinion.

Movement of the wrinkled blood corpuscles occasioned by strokes of small spirilli swimming in the serum.

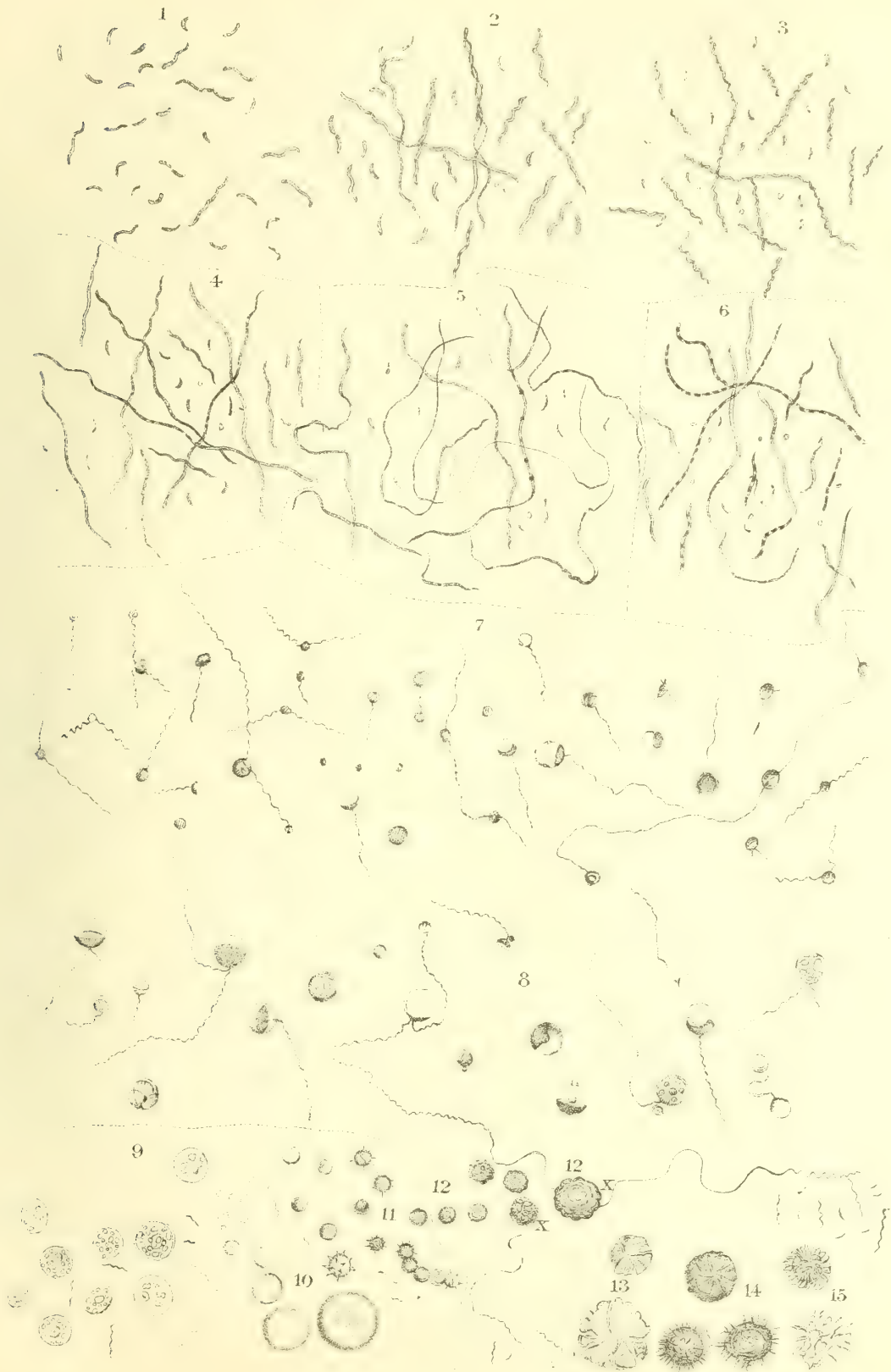
FIG. 12. Mulberry-formed body containing spirilli.

FIG. 13. The same cracked and shrunken after discharge of their contents.

FIG. 14. A mulberry-like body, having a downy envelope.

FIG. 15. Mulberry-like body, which was constituted by minute leaves, which finally separate and swim isolated in the fluid. (Ferrán's views concerning the morphology and biology of the comma bacillus of Koch, *Zeitschrift, f. klin. Med.*, Bd. IX, plate XI.)

FERRAN'S MORPHOLOGY OF KOCH'S COMMA BACILLUS







## SECTION 2.

## OBSERVATIONS OF FERRÁN ON MORPHOLOGY, ETIOLOGY, AND PREVENTIONS OF CHOLERA.

*THE BRÉANT PRIZE.\**

By his will, bearing date 28th of August, 1849, M. Bréant devised to the French Academy of Sciences the sum of 100,000 francs as a foundation for a prize to the discoverer "who should find the means of curing Asiatic cholera, or who should discover the causes of this horrible scourge." Until this full prize shall be gained, the annual interest accruing shall be awarded in annual prizes. In order to obtain these annual prizes, "it is necessary to demonstrate, by a rigorous process, the existence in the atmosphere of matters (or substances) capable of playing a rôle in the production or propagation of epidemic diseases."

In order to gain the principal sum, the Academy have decided that it shall be necessary "to discover a means of treatment which shall cure Asiatic cholera in the immense majority of cases," or "to point out in an incontestable manner the causes of Asiatic cholera, so that by suppressing them one may cause the cessation of an epidemic," or finally, "to discover a prophylactic certain and evident; for example, as that of vaccination for variola."

*UPON THE PATHOGENIC AND PROPHYLACTIC ACTION OF THE COMMA BACILLUS.*

By J. FERRÁN.†

Given a quantity of a culture of the comma bacillus made from colonies which have developed in plate cultures (derived from the germs which are directly contained in the stools of a cholera patient), and inject this culture into the subcutaneous cellular tissue of a young guinea-pig, two orders of phenomena will follow—the one local, a kind of phlegmasia; the other general, marked by a profound hyposthemia.

The maximum of virulence is obtained by inoculating into a very rich, slightly alkaline, bouillon a drop of white opaque material of one or more colonies and afterwards placing in the incubator at 37° C. just long enough to render the bouillon turbid. If the material made use of for the inoculation is very virulent one obtains a culture which in a dose of 2 to 4 c. c., can kill a guinea-pig. If the material is not quite so virulent this result is obtained only with larger doses. The local phlegmasia caused by the inoculation is found to be characterized by a warm and painful tumor, which may slough and leave a lardaceous eschar; the ulcer which supervenes heals spontaneously, without ever giving place either to the formation of pus or to symptoms due to putrefaction. The general symptoms which may appear are: Rapid fall of temperature considerably below the physiological standard, the latter being 40 C. in the rectum, if the bulb of the thermometer be introduced to a depth of 4 centimeters. Whilst these general symptoms become more rapid and foudroyant, it is obvious that the local phlegmasia is without importance.

If one takes a drop of blood from the injected, but still living animal, and inoculates it into a small quantity of bouillon, one obtains, after 24 to 48 hours of incubation at 37° C., a pure culture of spirilli capable of reproducing the same disease in indefinite series.

The microscopic examination of the serous fluid which escapes from an incision made at the point where the injection was received shows the following peculiarities:

(1) Extraordinary microglobulie, sufficient to cause doubts concerning the nature of what one sees, so great is the dissimilarity with the normal blood-corpuscles. Many of these blood

\* Comptes rendus des séances de l'Académie de Science No. 26, December 27, 1886.

† A letter addressed to the French Academy of Sciences by J. Ferrán, of Tortosa, Catalonia, March 31, 1885, and referred by the Academy to the committee on the Bréant Prize.—Comptes ren. de l'acad. des sci., 6 Avril, 1885.



corpuscles are covered with pointed spines, and possess a real movement, due, however, to the shock of the microbes against these points.

(2) Spirilli and commas, almost invisible on account of their rapid movements.

(3) Spherical cells filled with granules, some inclosing a granule which is distinguished by its size and resembles one of those degenerated blood corpuscles.

(4) Lenticular elements juxtaposed; they have divers diameters varying between 5 and 20 millimeters. Their appearance prevents them from being confounded with the other elements already described. This fluid being almost void of blood corpuscles, and its red color being quite marked, one is warranted in believing that the coloration is due to the hæmoglobine of the blood corpuscles. Serial cultures in gelatine preserve their virulence very well; on the contrary, the cultures in bouillon are attenuated at the end of a certain time.

If one takes a lot of guinea-pigs and injects them with a quantity less than half of the dose which is sufficient to kill them they acquire an immunity which renders them capable of resisting doses which previously would have infallibly killed them. In order that this result may be placed beyond doubt, one has only to take two lots of guinea-pigs of the same age, one lot having been previously endowed with immunity by means of the injections. If one injects mortal doses into the individuals of these two lots, those which have been previously cholericized resist, whilst the others succumb or become gravely ill.

*Effects of the microbe in man.*—Injection in the region of the brachial triceps of 8 drops of a very fresh virulent culture gives place to a painful and hot tumor which impedes the movements of the arm. This condition is followed by a local fever, which soon disappears spontaneously; 3 hours after the injection the development of a local phlegmasia commences and continues for 24 hours, after which time all feeling of malaise disappears almost completely without the production ever of phlegmons or eschars.

When one injects .5 of a cubic centimeter into each arm, the local symptoms are accentuated and general symptoms appear. Having regard to the most salient characters of the symptoms observed in each individual, one may construct a general picture of which the resemblance with that of true cholera is not to be contested: Marble-like coldness; hyposthenia; general lassitude; cramp; vomiting; heaviness of the head; cold, clammy sweat; evacuations more frequent than usual, but without the development of the true diarrhœa of cholera.

All these symptoms of hyposthenia are followed by a general hyperdæmia, which may reach 2.5 degrees above the normal temperature. More frequently there are more or less accentuated chills, general lassitude, heaviness of the head, disposition to vomit, and fever. All these symptoms, apparently alarming, cease after 24 to 36 hours, without the necessity of recourse to therapeutics. Sometimes these phenomena are more accentuated; the blood, which may be taken from no matter what locality, offers the same characters as the blood of the guinea-pigs subjected to the experiment already mentioned above.

The microglobulie is also manifest here, although to a less degree. Lymphatic cells and discoid bodies of various diameters are also to be met with.

If, 6 or 8 days after the injection of .5 c. c. into each arm, one re-injects into the same subject the same dose having the same degree of virulence, the general symptoms do not appear; very much less accentuated local symptoms are scarcely to be observed.

From these facts, so striking and easy to reproduce, one has the right to conclude:

(1) The possibility of cholerization in man, as of the guinea-pig, by means of hypodermic injections;

(2) That prophylaxis by cholerization is obtainable by means of an injection of a graduated virulence of dose.

I place myself at the disposition of the academy in order to reproduce before their eyes the experiments which I have just described.

(The author adds the names of a large number of persons who have been subjected to this cholerization; among others appear the names of himself, his assistant J. Pauli, and Juan Ferrán.)

*SUPPLEMENT TO THE NOTE SENT ON THE 31ST ON MARCH (1885) TO THE ACADEMY OF SCIENCES, CONCERNING THE PATHOGENIC AND PROPHYLACTIC ACTION OF THE COMMA BACILLUS.*

By JAIME FERRÁN, OF TORTOSA.\*

When I had the honor of sending to the learned academy my last note I thought I had expressed myself with sufficient clearness respecting the vaccine of experimental cholera. Inasmuch as this question may be soon taken up by the germ theorists in order to make application of it to the prophylaxis of Asiatic cholera, and since scientific reservations which I do not make have been attributed to me, I propose to demonstrate in this supplement (Madrid, July 11, 1885) to my note the incorrectness of such suppositions by explaining some points of my former note which may clear away the clouds of those who are looking for secrets.

Read the second paragraph of the said note, in which I set forth the manner of obtaining the virulent culture; see, then, in another place, in the first and second paragraphs of the note to which I have referred, the effects upon man, and it will be seen that I say the latter tolerates a cubic centimeter of the virulent culture.

By the second conclusion it is clearly and distinctly intimated that prophylaxis may be obtained by means of graduated doses without attenuation of any kind.

There exists, therefore, no secret. After my affirmation, that a culture of maximum virulence is well tolerated by man and that a graduated dose of this same culture produces prophylactic effects, it is not possible to make a more complete revelation of the supposed reservation.

Aside from this, I placed myself at the disposal of your learned academy in case they should desire that I should personally make an experimental demonstration before them of the effects set forth in my note.

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*ANOTHER NOTE UPON THE PROPHYLAXIS OF CHOLERA BY MEANS OF HYPODERMIC INJECTIONS OF PURE CULTURES OF THE COMMA BACILLUS.*

By JAIME FERRÁN.†

In my last note presented to this academy upon the pathogenic injections of the comma bacillus I said that the culture possessing a maximum virulence was perfectly tolerated by man. I said that a second dose equal to the first produced no general symptoms, although having a virulence equal to the first, and I concluded that the first inoculation confers immunity, securing better resistance against the effects of the second.

Having made application of these experiments in the prophylaxis of cholera, the results obtained are truly surprising, for, without fearing that subsequent experience may be contradictory, I affirmed to the academy that the means of cutting suddenly the mortality of an epidemic of cholera is to-day one of the conquests of science.

Numerous statistics and graphic charts, which I will soon submit to the examination of your learned academy, will demonstrate the truth of my assertion.

The manner of obtaining immunity against cholera is very simple, and at the same time harmless. The vaccine is nothing less than a pure culture of comma bacillus of Asiatic cholera in rich bouillon; the degree of virulence is directly in relation, up to a certain point, with the richness of the nutritive medium. Aeration, among other circumstances, favors the intensity of the culture.

The best vaccine is the most virulent; that is to say, that which produces the greatest number of cases of experimental cholera in the inoculated. The dose which I employed for all ages, commencing at two years, is that of 1 cubic centimeter in each arm. The symptoms developed, although having sometimes considerable intensity, necessitate no recourse to

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\*Abstract from *La inoculación preventiva contra el colera*, by J. Ferrán, Valencia. 1886.

†Presented to the French Academy and referred by it to the committee on the Bréant prize.—(Compt. rend. de l'acad. des sci., 13 July, 1885.)



therapeutics. Three inoculations are necessary in order to obtain a profound immunity. I perform one every 5 days with a dose of 2 cubic centimeters in both arms, into the cellular tissue of the brachial triceps, which makes a total of 6 cubic centimeters of bouillon culture.

The microbe does not multiply in the cellular tissue, and its prophylaxis is due, in my opinion, to a sort of tolerance or habituation of the organism to the rapidly diffusible substance carried by the microbe. The immunity produced by these means does not seem to me, therefore, to be anything else than a phenomenon of tolerance against the above-named substance, which can be produced and absorbed in the case of an ordinary intestinal infection.

The dangers of attack and death begin to disappear 5 days after the vaccination, and the guaranty of immunity augments with the successive vaccinations.

The elimination of the active substance produced by the bacilli with the milk of nurses gives origin in nursing infants to an experimental cholera, always, however, without gravity; the milk, the stools, the sweat, the vomit of the inoculated, furnish no comma bacilli under culture.

All the phenomena produced by this active principle seem to be due to an action exercised upon the nerve centers.

When one wishes not to obtain very intense general symptoms with the vaccination, one operates with a culture containing fewer germs, which is the case with the first vaccine.

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#### *A POISON ELABORATED BY THE COMMA BACILLUS.*

By J. FERRÁN.\*

As may be seen, the principal aim of the considerations up to the present advanced is the demonstration that the infective diseases are nothing else than toxic processes, more or less acute and complex, and that the subsequent immunity is intimately related to a phenomenon of toxic habit, due to the modification of the organism, which, in proportion as it confers a greater resistance by tolerance of the poison, leaves the body sterile for a second culture of the pathogenic microphite; from all of which it results, on the one hand, that the dangers of grave intoxication, in case an infection take place, very much decrease, and, on the other, that the inoculations powerfully diminish the risk of such a thing taking place. In order to give full value to this theory it would be necessary to obtain, experimentally, with a dead microphite, or with its poison, isolated by means of chemical processes, the same results which are obtained with the inoculated living comma bacillus. Of the experimental proof of this we have given an account in the last two notes we directed to the Academy of Sciences at Paris, and which we transcribe below:

NOTE ADDRESSED TO THE ACADEMY OF SCIENCES OF PARIS, JULY 31, 1885, BY J. FERRAN, CONCERNING THE CHEMICAL VIRUS OF CHOLERA.

In my last note addressed to that learned academy I set forth the idea that the immunity occasioned by the hypodermic injections of the comma bacillus might be interpreted as the effect of accustoming the organism to the poison of this microbe. My supposition was founded upon the circumstance that the said bacillus could not be produced in the cellular tissue; but this was insufficient for the demonstration in an irrefutable manner that we had to do with nothing more than a habit, such as a chemical substance void of life might be able to produce because it was logical to admit that the microphyte while it was unable to reproduce itself continued to live and that the prophylactic effects might be attributed to phenomena purely vital.

There was presented before me a direct way for the elucidation of the true nature of the phenomena: To study the pathological and prophylactic properties of a dead culture.

If after having assured myself of the death of a culture by means of an inoculation which

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\* Chap. XIX. La inoculacion preventiva contra el colera, by Ferrán, 1886.

was fruitless, I injected a lot of guinea-pigs with from 2 to 8 cubic centimeters of the dead culture, the said animals exhibit the symptoms described in my first note. If after recovery I injected them with the dose of the living culture capable of producing death in similar animals of the same size, they remained immune, whilst those which had not been previously inoculated with the dead culture died under the action properties of the living culture.

Now, then, as this dead culture is not lacking in action upon man, since it produces in him almost all the same effects as does the living culture of the bacilli, many have immunity by reason of the constitutional effects determined by an injection of the same size as the first, it is logical to admit that the said injection may have a preventive power against Asiatic cholera.

If the effect may be generalized, the same criterion might apply to the study of the effect obtained by artificial virus as to that of the results produced by certain medicines and poisons.

The intensity of the clinical phenomena would be always in relation with the weight of the individual and the quantity of the virus or of the toxic matter injected. According to this death would be due to the extraordinary adaptability of the choleraic microbe in the intestines, for the quantity of the poisonous plant which is formed in this locality is very considerable and the choleraic intoxication exceeds many times the maximum of individual resistance. This may not happen when the dose of the poison may be limited by limiting the production of the bacillus, a thing which happens in inoculation, and especially if we make use of a dead culture in which this elimination is still more absolute.

The greater or lesser adaptability of a microbe in a medium dead or alive the greater or lesser facility of perpetuating its species is in the microbes, as in all the seeds or plants (or plant), the result of two factors equally powerful, the subject and the medium. This being so, it is clearly understood how the adaptation may be reduced to zero in the same way that it can be augmented without changing the condition of a medium and without exercising any direct action upon the pathological microbe.

There are two examples of this in the microbe cholera and in that of symptomatic charbon. In the first case the cellular tissue, not presenting an adaptability for the comma bacillus, converts it into a virus without, the principles of which have not lost their toxicity, and in the second the same effect with respect to the specific bacteria is produced in another manner. Both microbes may be mortal. If they are lodged in ground favorable for their multiplication, the duodenum for the comma bacillus and the loose cellular tissue for the microbe of symptomatic charbon.

By that which we have just explained the question of chemical virus seems to be solved; but further, it permits me to anticipate at once the idea that chemical virus of all the pathogenic microbes, whose active principles may not be alterable by causes of their destruction, may be obtained; it being of little importance for the arrival at such a point whether their active principles be isolated or not by chemical processes. The possibility of obtaining immunity against cholera by means of pharmaceutical formula whose base may be the choleraic microbe or its active principle is therefore seen in prospective, for it is logical to foresee that these means may not attain the practical value of hypodermic injections of the comma bacillus.

The fact that the dead pathogenic microbe produce immunity against their own effects is not wanting in analogies in toxicology. In certain villages of Aragon in which the microscopic poisonous fungi (the mushrooms) are very abundant, urged by want the inhabitants end by eating them in abundance after having first accustomed themselves to them, during which time they suffer great disturbances of health (symptoms followed by death) produced by the first ingestion of the *toxicophytes*.

Neither does the fact of the permanency of the toxicity of the microscopic fungi after their death want precedence; it is known that certain pathological microbes determine the formation of pus although they are injected dead.

I will not stop to demonstrate the importance of this theory of the chemical virus or to speak of the immensity of the field which it opens to applied bacteriology, for it is self-evident.

I beg the academy to accept this note in competition for the Breant prize."



## THE ACTIVE PRINCIPLE OF THE COMMA BACILLUS AS THE CAUSE OF DEATH AND OF IMMUNITY.

By FERRÁN AND PAULI.\*

In a note sent by one of us to the Academy of Sciences on the 31st of last July, it was stated that the dead comma bacillus, when injected, gives immunity against the effects of the same bacillus injected alive, and from this was deduced the possibility of protecting ourselves against the virulent diseases by accustoming ourselves to the active chemical substance which the microbe produces. To-day we lay before the Academy new proofs in confirmation of the ideas already expressed.

*First experiment.*—Ten guinea-pigs of 130 grammes weight each are taken and injected hypodermically: 1 c. c. of dead culture into 2 guinea-pigs; 2 c. c. of dead culture into 2 guinea-pigs; 3 c. c. of dead culture into 2 guinea-pigs; 4 c. c. of dead culture into 2 guinea-pigs; 5 c. c. of dead culture into 2 guinea-pigs.

Eight days afterwards new injections of dead culture following the same order and employing the same quantity. The third injection after another eight days under the same conditions as the two preceding.

Although less accentuated, the effects produced by these injections are the same as those pointed out in our first note, and, having regard to the quantity of the inoculated culture, we are authorized in affirming:

(1) That these effects are proportional up to a certain point to the quantity of the material respectively injected.

(2) That these effects decrease to a certain point in proportion as the animal has received a greater number of injections.

*Second experiment.*—We began by determining the minimal dose of the living culture which is required for a certainly fatal inoculation of the guinea-pig, and whatever this might be it is injected into 10 guinea-pigs previously inoculated with different doses of the dead microbe, then is observed a phenomenon inverse to that of the former experiment.

The effects are inversely proportional to the dose of the dead culture in the first experiment; thus it is that the guinea-pigs which were inoculated with the weaker dose are precisely those which most experienced the effects of the second injection.

Habituation, that is the acquired resistance, augments up to a certain point proportionally to the quantity of the injected poison.

*Third experiment.*—From a culture of the comma bacillus its active principle has been extracted by means of one of the processes of obtaining the alkaloids. We have tried various of these processes, and among others that of Stas-Otto, analogous to that which Bergmann employed for the extraction of sepsin—the precipitation by tannin, the employment of an energetic base, etc. We have modified this process in order to extract the alkaloid by means of the action of oxygen, which does not appear to modify profoundly the physical constitution of the alkaloid.

These different procedures gave us a product possessed of characteristic properties, and whose physiological action has a very surprising resemblance with that described in the former note.

The active principle extracted from a liter of comma bacillus culture is dissolved in 6 c. c. of water.

The following are the results of the injection of this liquid:

Into six guinea-pigs having a weight 130 grammes, 1 c. c. of the aforesaid solution is injected into the cellular tissue of the abdominal wall. After ten days a new injection of 2 c. c. is performed, and ten days later a third injection of 3 c. c. In ten days after this a new lot of six guinea-pigs, which have suffered no inoculation, is taken, and both lots are injected with a mortal dose of a culture of the living comma bacillus.

The six guinea-pigs which had suffered the inoculations of the ptomaine and acquired consequently a certain degree of tolerance resist perfectly and show themselves quite indifferent to the pathogenic action of the comma bacillus; of the six others all die.

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\* Sent to the Academy of Sciences at Paris on the 13th of January, 1886, by Ferrán and Pauli.

*Fourth experiment.*—Six guinea-pigs weighing about 130 grammes are taken and injected hypodermically with a cubic centimeter of living culture. Five days afterward a new injection of two cubic centimeters, and finally eight days afterward another injection of three cubic centimeters. Twenty days from the first injection, another lot of six guinea-pigs, of the same weight, without previous inoculation are taken, and into both lots of guinea-pigs a morta dose of the ptomaine abstracted from the comma bacillus cultures is injected. The results are surprising; the guinea-pigs inoculated, resist; all the others die.

In order that the results may be conclusive, it is of the greatest importance in all of these experiments to have the greatest uniformity in weight of the animals, in the nature of the bouillon and in the density or richness in germs of the cultures. The bouillon which we used was composed of 16 liters of water; Cibil's fluid beef, 180 c. c.; Liebig's extract of meat, 30 grammes; gelatine 30 grammes.

The culture flasks have a capacity of a liter and were half filled. The air within them is renewed whilst leaving the contents undisturbed. The incubation temperature is 37° C. The age of the cultures, 6 days.

The processes employed for the extraction of the ptomaine from the cultures were tried upon bouillon without microbes. The portion which contained the active principle, when dealing with the cultures of the comma bacillus, was inoculated without result.

#### CONCLUSIONS.

(1) The dead comma bacillus culture confers a tolerancy which secures resistance against the effects of the living bacillus.

(2) An active principle generated by the comma bacillus, isolated by known methods, confers the power of resisting the effects of the living microbe, and vice versa.

#### FINAL CONCLUSION.

In these experiments, the cause which determines the immunity and that which produces death are the same, and are essentially of a chemical nature; consequently immunity is nothing more than a phenomenon of habit which can be obtained by means of purely chemical agents. Belonging, as the phenomenon does, to a class of facts known from ancient times, that of habituation to medicine or poison, the theories concerning this habitation are those which must be invoked to explain the immunity.

Sealed preparations accompany this note, made from the cultures which we have employed in our experiments; and we pray the Academy to receive this communication in competition for the Bréant prize.

#### LATER EXPERIMENTS OF FERRÁN AND PAULI ON THE ETIOLOGY AND PROPHYLAXIS OF CHOLERA.\*

In a recent brochure published by Drs. Ferrán and Pauli in 1886, they give an account of later experiments which they have made concerning the etiology and prophylaxis of cholera, especially with reference to the products of the comma bacillus. At the end of this brochure appear the following conclusions, which they believe are supported by their experiments:

#### CONCLUSIONS.

(1) The microbe of cholera, besides the forms described by Dr. Koch, presents in the spirilli spherical transparent dilatations (ögonia) of variable size, reaching sometimes that of a leucocyte, with an envelope opaque or translucent.

(2) In the interior of the spirillum or of the comma, as well when it has grown in the depth of the medium as when it develops upon the surface of the gelatine material, brilliant and spherical spores appear, capable of undergoing extraordinary developements.

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\* Tortosa, November 10, 1885.



(3) These spores when ripe extrude spirilli or commas from their interior.

(4) The skeletons or shells of these spores present the appearance of spheres, divided by septa and surrounded by a plush like envelope which is considered by some as crystalline, but they do not at all correspond to the physico-chemical characters belonging to crystallized bodies.

(5) Cholera is an acute intoxication, occasioned by an intestinal mycosis the cause of which is the comma bacillus.

(6) The virus, or active principle of the microscopic fungus which occasions the cholera, is of the nature of those to which man, and certainly animals, may become habituated.

(7) The heat necessary to cause the death of this fungus does not destroy the activity of this virus (or poison).

(8) Sufficient quantities of the dead fungus can also produce effects as well as the living fungus.

(9) The active principle of the comma bacillus, isolated by means of known chemical methods, produces tolerance to the effects of the microbe injected alive, or *vice versa*.

(10) The effects occasioned by the microbe, or by its active principle, are, up to a certain point, proportional to the quantity injected.

(11) The tolerance is, up to a certain point, proportional to the number of vaccinations received and to the quantity of the culture employed.

(12) In man only does this fungus naturally adapt itself and propagate itself readily in the intestinal canal.

(13) The fungus injected into the cellular tissue gives immunity for a certain time, but it does not propagate there.

(14) The best method of habituating one's self to the virus of this pathogenic agent is by hypodermic injections progressively increased in quantity—the anti-choleraic vaccination does not consist in anything else.

(15) Cultures of maximum virulence can be injected with impunity into the subcutaneous cellular tissues without ever producing phlegmons, provided they are pure.

(16) The results of habituation or tolerance, acquired in this manner, are a progressive loss of individual susceptibility to contract cholera, and a lessening of the probability of death, in case the disease is contracted.

(17) These facts occurring with that constancy and marked regularity which constitutes the decided characteristic of all facts subjected to a rigid law, all those sanitary measures which interfere with commerce and international relations as well as the intercourse between towns and individuals, may be abandoned.

(18) The creation of international anti-choleraic vaccination institutions at places deemed to be necessary, in order that exit may be forbidden to whomsoever does not present a certificate of recent re-inoculation, could free us from the danger of importation of cholera far more than the enforcement of sanitary measures, just as effectual anti-choleraic vaccination of villages, in case of importation, will arrest the progress of the epidemic and cut it short at its origin in a manner more efficacious, certain, and economical than by other means which experience has shown to be fruitless.

TORTOSA, November 10, 1885.

## SECTION 3.

## OBSERVATIONS OF LÖWENTHAL AND GAMALEÏA ON VIRULENCE OF CHOLERA VIRUS AND PREVENTION OF CHOLERA.

## BIOLOGICAL AND THERAPEUTIC EXPERIMENTS UPON CHOLERA.

By W. LÖWENTHAL.\*

I have the honor to submit to the Academy a résumé of a series of experiments begun in the month of May last, relative to the conditions of life of the bacillus of cholera.

I sought at first to re-endow the cholera bacillus, by an artificial method, with the toxic property which it possesses in the fresh state and which it loses when it has been cultivated a long time in artificial nutrient media as employed in the laboratories. In fact, the pure culture of these bacilli in peptone bouillon is, after subsequent sterilization, absolutely inoffensive for white mice upon which I have experimented; it contains no toxic ptomaine produced by the bacilli, although it gives with hydrochloric acid the characteristic reaction (cholera-red).

After having tried ineffectively as culture media—besides bouillon—gelatine, agar-agar, milk, and pastes of diverse composition, I have succeeded with a special paste composed of the following substances: Hashed pork-flesh (500 grammes), hashed pancreas of the pig (200 grammes), vegetable flour (*farine légumineuse*) of Maggi or of Groult (100 grammes), peptone (15 grammes), grape sugar (10 grammes), ordinary table salt (5 grammes). These materials mixed with water, or with milk, form a soft, almost fluid, paste, which is made alkaline in the ordinary manner; then it is placed in sterilized test-tubes of large diameter, and sterilized on three days consecutively in the steam sterilizer, and is then used as other culture media.

After developing in this paste, the same bacilli which have produced no toxic substance in the bouillon now at once form a poison which kills or makes very ill the mice into which it is injected, or to which it is fed by way of the stomach. The conclusive experiment is this: At the same time, an ordinary bouillon culture and a paste (as above prepared) are inoculated; both test-tubes remain 48 hours in the incubator at 37° C.; they are then both sterilized together in the sterilizer; 1 gramme of the bouillon and an equal quantity of the juice of the paste is now injected into the peritoneal cavity of two mice, respectively (injection made with every usual precaution and notably at a temperature of 37° C.); the mouse, which has received the bouillon will not suffer at all from the injection, whilst the other mouse will be gravely ill in a short time after the injection, and will die or will slowly recover in the following 24 or 30 hours.

By varying the components of the mixture I have been ultimately able to demonstrate that it is the *pancreatic juice* which, in the presence of albuminoid and peptonized substances determines the toxic action of the bacilli; all the other substances mixed together, with the exception of the pancreas, form as good a medium for the development of the bacilli as does the bouillon or agar-agar, but no toxic substance is produced.

This action of the pancreatic juice explains to us the clinical picture of cholera in man. The ingested bacilli having succeeded in passing the stomach and reaching the intestine generate there, by aid of the pancreatic juice, the same toxic substance as in my paste, which is only a coarse imitation of the contents of the duodenum; this toxic substance will be absorbed the recovery or the death of the patients will be in relation with the quantity of the poison absorbed, and with the resistance of the organism. The experimental fact tallies perfectly with the anatomo-pathological, viz, that the bacilli of cholera always remain limited to the intestines; it explains the *foudroyante* cases of cholera, as well as the experiments upon animals, performed by Nicati and Rietsch, and by Koch.

This point once determined, I said to myself, if I should succeed in finding a substance harmless for man, yet which would prevent the development of the cholera bacillus in my

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\*Comt. rend. de l'acad. de sci., Paris, 31 Dec., 1888.



pancreatic paste, we might be able to say with the greatest probability that the laboratory experiments could give, what we have attained in this case, an ideal of therapeutics in bacteriology, that is, the destruction, in its actual location, of the pathogenic micro-organism without injuring its host; that we perhaps possess a specific remedy, preventive, and curative against cholera in man.

I have succeeded in finding this substance. It is *salicylate of phenol* or *salol*, discovered in 1886 by Nencki, of Berne. After having tried without result opium and tannin, I thought of salol, because this powerful antiseptic is *decomposed in the organism by the pancreatic juice*, that is to say, by the same agent which renders toxic the cultures of the cholera-bacillus in my pancreatic paste. I had then reason to hope that salol would act in the manner described. This hope has been realized. Salol, in the presence of fresh pancreatic juice, kills the bacilli of cholera, developed in a paste previously inoculated, and, on the other hand, it makes the paste sterile when one first mixes the latter with the salol and afterwards makes the inoculation. In order to be absolutely sure of this action, I added to the sterilized paste, which was still alkaline, as much as 3 cubic centimeters of pure bouillon culture of the bacilli. Notwithstanding the inoculation with such an enormous quantity, the paste remains sterile. This effect is absolutely certain with 2 grammes of salol to 10 grammes of paste, and in diminishing the dose of the salol as far as to .10 of a gramme, the majority of the cultures also remain sterile, only two were not so, *but these two did not contain comma bacilli, and did not give the reaction with hydrochloric acid.*

To be applicable clinically, the agent, deleterious for the bacilli, must be harmless for man. Salol, as one knows, is inoffensive for the human being.

In view of the results which I have thus briefly set forth, I believe myself warranted in proposing to try on a large scale and upon man this harmless remedy, which destroys the cholera bacillus in a test-tube. I do not see at present any reason which would prevent salol from displaying the same activity in the intestinal contents of man which it exhibits in the artificial imitation of these contents, the trial is therefore justifiable.

As to the quantity of the dose, I would propose the administration of the salol until fuller information, based upon clinical experience, in the following manner: As a *prophylactic* three times a day during the principal meals, 2 grammes each time; as a *therapeutic* remedy, an initial dose of 4 grammes on the appearance of the first symptoms of cholera, and afterwards 1 gramme every hour. As high as 20 grammes of salol may be administered a day.

#### PREVENTIVE VACCINATION OF ASIATIC CHOLERA.

By Dr. GAMALEÏA OF ODESSA.\*

The following investigation is only a simple and faithful application of the *experimental method* which has been devised in the laboratory of M. Pasteur and which has already given such beautiful results in chicken-cholera, rouget, anthrax, and rabies. The author has only applied to cholera two grand principles of the experimental method: that of progressive virulence and that of chemical vaccine.

It is known that the ordinary cultures of the comma bacillus have only a minimal virulence. This is so much the case that Koch, who discovered the germ, believed after numerous failures that Asiatic cholera was not inoculable into animals.

On the other hand, the pupils of Pasteur, on the occasion of the French expedition into Egypt, only a single time succeeded in producing cholera, and that in a chicken.

Now, it is easy to endow the cholera bacillus with an *extreme virulence*. For this, it is only necessary to introduce it into a carrier-pigeon after a passage through a guinea-pig. It then kills the pigeon by giving it cholera *sec* with desquamation of the intestinal epithelium;

\* A memoire communicated to the Institute Pasteur and to the Academy of Medicine, 20th to 21st of August, 1888, by M. Pasteur, in the name of the author. Gazette hebdomadaire de médecine et de chirurgie, No. 34, August 24, 1888.

but what is still more important, the microbe also appears in the blood of the pigeons which have died.

After a few passages through the pigeons the microbe acquires such a virulence that the blood of the carrier pigeon experimented on in the quantity of 1 to 2 drops kills every fresh pigeon in the space of 8 to 12 hours. This virus also kills guinea-pigs with still smaller doses. It is important to know that all the animals of these two species succumb to the virulent infection. With this absolutely mortal virus the author has been able to demonstrate a cholera immunity. Thus he has inoculated a pigeon twice with an ordinary (non-virulent) culture of cholera; the first time into the pectoral muscle, the second time into the abdominal cavity; this pigeon became refractory to repeated infection by the most virulent virus (the blood of the carrier pigeon). The existence of immunity has been thus acquired.

But if one cultivates this virus of passage in a bouillon, and if one subsequently heats this culture up to 120° for 20 minutes, in order to certainly kill all the microbes which it contains, one demonstrates then that the heating has allowed a very powerful substance to remain behind in the sterilized culture. This culture, in fact, contains a toxic substance which produces the characteristic phenomena in the animals experimented upon.

Inoculated in the quantity of 4 cubic centimeters into the guinea-pig, this sterilized bouillon produces a progressive falling of the temperature and death in 20 to 24 hours (at the autopsy one finds a pronounced hyperæmia of the stomach and of the intestines, but naturally a complete absence of cholera microbes).

The pigeons succumb also with the same morbid phenomena, only they are more resistant to this poison, and their death occurs only after a dose of 12 cubic centimeters injected at one time. If, however, one introduces this same quantity of 12 cubic centimeters, but divided into 3, 4, or 5 portions on different days (by injecting, for example, 4 cubic centimeters on the first day, and 8 cubic centimeters on the day after), one no longer kills them.

Furthermore, with these pigeons a fact of the very greatest importance is demonstrated; they become refractory to cholera; the most virulent virus, the blood of the carrier-pigeon, inoculated in the quantity of a half a cubic centimeter, is no longer capable of killing them. The vaccination of the guinea-pigs succeeds still more easily; by introducing into them the toxic and vaccinal bouillon in the quantity of 2 cubic centimeters, they become vaccinated in two or three operations (only 4 to 6 cubic centimeters being used).

Thus we are in possession of a method of preventive vaccination of cholera. This method is founded upon the employment of a sterilized vaccine and it possesses all the advantages of chemical vaccination—*surety* and *safety*—since the chemical virus may be measured in an exact manner and introduced in doses sufficiently small to be entirely harmless, whilst by repeating the doses the desired quantity necessary for a complete immunity may be given.

So, in these experiments immunity is conferred *without danger* and *without exception*. The author hopes consequently that this method may be applied to human vaccination in order to protect populations against Asiatic cholera.

Gamaleïa declares that he is ready to repeat all of his experiments in the laboratory of M. Pasteur, in the presence of a commission of the Academy of Sciences. He also offers to discover by experimentation upon himself the harmless yet effective dose for human vaccination, as also to undertake a voyage to countries ravaged by cholera, in order to prove the efficacy of his method.

After having asked that the communication of M. Gamaleïa be sent to the committee on the Bréant prize, M. Pasteur expressed himself in the following words:

“As for myself, it is useless to say that I accept with readiness the proposition that the experiments of M. Gamaleïa be made in my laboratory. That savant has already at several times worked among us, notably in the year 1886, when he was sent to Paris by the municipality of Odessa at the demand of the learned association of Russian physicians of that city, in order to study the mode of preventive inoculation against hydrophobia, a method of which he to-day makes known so remarkable an extension and application to the preventive inoculation of Asiatic cholera.



"But, as he modestly states, he has added to the methods of my laboratory the inspiration which he has obtained from the pages published by me upon the chemical vaccination of rabies in the first number of the *Annales del Institut Pasteur* by M. Duclaux, and from the beautiful and decisive experiments of Dr. Roux upon chemical vaccination of septicæmia in the number of last December of the same *Annales*.

"Since the labors of which I spoke, discoveries increase and accumulate concerning chemical vaccine. We should not doubt that we shall soon possess knowledge that we can not be slow to recognize and utilize."

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*CRITICISM OF THE CLAIMS OF LOEWENTHAL AND GAMALEIA.*

HUEPPE (Sur la virulence des parasites du cholera. *Gaz. Heb. de Med. et Chir.*, 25 Jan., 1889), in reply to the works recently published by Gamaleïa and Loewenthal, calls attention to the fact that in the Medical Congress at Wiesbaden, April 10, 1888, Loewenthal being present, he first demonstrated variations in virulence of cholera bacilli in culture media; and after having sought for a therapeutic antagonist for them, he gave the first rank, from the double point of view of physiology and pharmacology, to tribomophenal, salicylate of bismuth, and salol.

Since then, in an article anterior to the communications of Gamaleïa and Loewenthal, which appeared in the *Centralblatt für Bacteriologie*, Vol. V, p. 80, the author showed that a simple culture of the cholera bacilli, possessing little or no virulence, when cultivated in a favorable medium where they lead an *anaerobic existence*, for example, albumen of white of egg endows that culture fluid with toxic qualities which it does not acquire, or acquires only after a long time, in the case of cultures in ordinary media under *aerobic* conditions. Thus a culture 48 hours in egg albumen becomes sufficiently toxic to kill 2 of 3 guinea-pigs, and to make the third very sick; whilst 4 weeks of aerobic culture in bouillon produces a liquid which has scarcely any virulence.

Hueppe explains the difference of these results by assuming that in the anaerobic cultures the ptomaines and basic products resulting from the breaking up of the albuminoid materia are not ulteriorly destroyed, whilst on the other hand, they are oxidized in the case of aerobic cultures. If this be true, one may ask one's self if the same would not be the case in the special mode of anaerobic existence which Gamaleïa in the body of a carrier-pigeon, and Loewenthal in the bottom of a deep flask containing his infusion of pancreatic juice, imposes upon the microbes.

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*THE VIBRIO METSCHNEKOVI AND ITS RELATIONS WITH ASIATIC CHOLERA.*

By M. N. GAMALEÏA.\*

In studying the sanitary state of the fowl market of Odessa we have discovered a new infectious disease of chickens which presents in several respects a particular interest.

This disease is more frequent with us in summer than chicken cholera, and cases of it appear to multiply and increase with the heat of the air, and particularly of the sun. Principally young chickens are attacked with this disease; however, we have also met with it in old chickens.

By the external symptoms, this disease, which we propose to call *gastroënteritis cholERICA of birds*, does not differ much from septicæmia. The sick birds are motionless, as though asleep, with ruffled plumage; they have diarrhœa. However, the confirmed disease is of longer duration than septicæmia; old chickens can remain in this sleepy state for forty-eight hours and longer. A very sharp clinical difference between the two diseases is given by the degree of temperature; whilst chicken cholera presents an intense fever until death (43–44° C), our new disease is characterized by a temperature nearly normal (41–38° C).

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\* *Annales de l'Institut Pasteur*, 1888.

At the autopsy the most constant phenomenon is a hyperæmia of the whole digestive canal, from the œsophagus downward, which is filled with a viscid fluid. The small intestines contain a large quantity of fluid of a yellowish gray color, with more or less blood. The other organs have a normal aspect. A very interesting differential sign from septicæmia is a complete absence of hyperæmia of the spleen, which always remains small and pale.

The microscopic examinations reveal nothing ordinarily in the blood. Besides, the blood of the old fowls is sterile and non-infectious. But, in poulets one can experimentally ascertain the presence of specific bacteria in the blood. Pigeons, notably, inoculated with a large quantity of this blood (2 to 4 cubic centimeters of a rather thick emulsion) perish in twelve to twenty hours. In these pigeons one finds at the autopsy the same lesions as the above mentioned: Spleen bloodless; intestines filled with sero-purulent contents, colored with blood. In the blood of the heart is found ordinarily an enormous quantity of characteristic bacteria, which have the aspect of the comma bacilli of Koch. The same bacteria is found again mixed with others in the contents of the œsophagus and in the intestines of pigeons and chickens which have died from choleraic gastro-enteritis. The blood of the pigeon contains them in the pure state and furnishes immediately pure cultures of them.

The commas which we observed have ordinarily in the blood of the pigeons the form of a large bacillus, short and curved, with the ends rounded. They are found sometimes joined in spirals, with from five to ten turns more or less contracted. Sometimes one meets double spirals turned like a cord loosely wrapped around itself. Their size is not constant; in the blood of pigeons they have only the ordinary diameter of the choleraic commas of Koch, whilst in the carrier-pigeon they become twice as large. These bacteria are easily cultivated in ordinary culture media. In veal bouillon, quite alkaline (with or without peptone), they multiply very quickly, and, six or seven hours after the inoculation, can be seen with the naked eye a uniform cloudiness which resolves itself into silky waves when agitated. The next day the liquid is covered with a thin white film. This film remains thin and fragile the following days, when it forms under it a dense opaque and gray stratum. Microscopic examinations reveal in these cultures the existence of the same curved bacteria which unite sometimes in very long spirals. In hanging drops one ascertains that the living bacteria are endowed with a rapid spontaneous movement. These cultures in ordinary bouillon have no pronounced odor.

The reaction with sulphuric acid gives an orange color to the culture of these bacteria in peptonized bouillon.

After a puncture in the nutritive gelatine (5 per cent.) our bacteria develops rather slowly. The second or third day one sees a bubble of gas which becomes larger the following days and lengthens at the base like a cylinder of liquified gelatine, then the central axis has a small white band running around it like a spiral. Later the bubble disappears by widening more and more at the top until the sides of the tube are reached; it terminates below in a funnel-shaped extremity, the bottom of which is occupied with masses of white granules. In the gelatine-plate cultures a typical appearance, visible to the naked eye, is found on the third day. The isolated colonies have the form of a transparent liquified zone showing a white spot at the center. Examined by the microscope these colonies are divided into three zones, the exterior zone composed of liquified gelatine is very pale with a homogeneous structure, the intermediate zone has undulated borders and a granular appearance, while the center is brown and opaque.

The cultures on agar-agar often have a characteristic appearance; they are composed of whitish layers raised at the center, where they have a yellowish tint and are covered with a glistening surface.

On potatoes our bacteria develop above 25° C., in masses of a pale brown color (*café au lait*), darker (*couleur de bière brune*) at the center.

These bacteria develop very well in milk, which does not change its appearance during the first days, but about a week later it coagulates (at 35° C.); the casein is precipitated to the bottom in irregular masses which do not again re-dissolve. The milk acquires at the same time a strong acid reaction and the bacteria perish therein in a rather short time.

The cultures in eggs are typical. Ten days after the inoculation, one finds upon breaking the shell, that the white of the egg is quite dissolved and transformed into a cloudy, yellowish



liquid. While the yolk preserves its form and consistency it becomes perfectly black. Our bacteria are very sensible to the action of high temperature. Heated 5 minutes at 50° C. they are killed; for 1 or 2 minutes at 50° C. they are still quite alive, and the same is the case when they are heated at 45° C. for ten minutes.

In some special conditions our bacteria form real spores (en dospores) characterized by double coloration. But we will give a more complete description of them later.

Characterized in this manner, our bacteria, by reason of their mode of sporulation, are to be classed as vibriones. Consequently we propose to call them *Vibrio Metschnikovi* in order to distinguish them from vibriones which they resemble (*vibrio cholerae asiaticæ*, Finkler et Prior, Denecke).

It is incontestable that the vibriones of Metschnikoff constitute the sole cause of choleraic gastro-enteritis. From our experiments they are pathogenic for pigeons, chickens, and guinea-pigs.

Pigeons are very susceptible to the action of our bacteria. A few drops of the culture, inoculated under the skin or into the muscles, are sufficient to kill them in from eight to twelve hours. It is necessary, moreover, to remark that the bacteria obtained from the body of chickens do not always possess this extreme virulence, which they always obtain by successive passages through pigeons.

Thus, for example, on the 20th of June 1 cubic centimeter of the blood of a pigeon (second passage through a chicken) is inoculated into two pigeons. Only one of these dies, while the other recovers and becomes refractory to virulent virus. The 9th of July the same bacteria, after daily passages through pigeons, becomes absolutely fatal to the latter in a dose of an eighth of a cubic centimeter.

With this increasing virulence an interesting change occurs in the contents of the inflamed intestines of the pigeons which have succumbed. These contents always consist of a rosy liquid with small grey flakes; but with a weak virus, these flakes, under microscopic examination, are composed principally of leucocytes while with the most virulent virus exfoliated epithelial cells only are found in these flakes.

Our bacteria have no action on pigeons when *fed* to them even in very large quantities. Chickens, on the contrary, which are more refractory to the vibriones of Metschnikoff, which require much stronger doses in order to be killed by subcutaneous or intramuscular inoculation, succumb easily to infection by feeding.

Thus, on the 27th of July, a chicken swallowed some blood of a pigeon, dead from choleraic gastro-enteritis (second passage through a chicken which had succumbed to the spontaneous disease). This chicken died in the night of the 29th or 30th of July. The intestines were very hyperæmic and filled with a fluid containing gray flakes. In its blood Metschnikoff vibriones could be found and isolated therefrom. Evidently this chicken was infected through the alimentary canal. I do not wish, however, to assume anything concerning the natural mode of infection, which forms the object of our present researches.

Rabbits and *spermophiles* are very refractory to our bacteria, although they can be killed by large quantities. Guinea-pigs, on the contrary, are more susceptible. They do not resist any mode of virulent inoculation, and even succumb to infection by the way of the alimentary canal. It is not even necessary to neutralize the gastric juice with soda or to intoxicate the animal with the tincture of opium, etc.; it is sufficient simply to make them swallow several cubic centimeters of a virulent culture. Thus, on the 13th of August, two guinea-pigs swallowed 4 cubic centimeters in a culture in bouillon dating from August 11th. The next day both were dead. At the autopsy the spleens were anæmic; the intestines were filled with a fluid containing desquamated flakes of epithelium. One of them had a serous exudation in the pleural cavity. The vibriones were found in the blood of the heart and in the contents of the intestines.

In short, one can conclude concerning the pathogenic action of our microbes that they have a tendency to fix themselves in the intestinal canal, where they occasion desquamation of the epithelium; that this localization also takes place after subcutaneous intramuscular or intraperitoneal inoculation; that the animals resisting are killed only by the local multipli-

cation of the microbes, probably by means of ptomaines, which they elaborate; that in susceptible animals (chickens, pigeons, guinea-pigs) the microbes enter the blood, in which they acquire increased virulence.

If, now, one compares all the data which we have acquired up to the present concerning the properties of our microbes with the well established facts respecting the microbes of Asiatic cholera of Koch, one is struck with the great resemblance of these two forms: the same morphological appearance: no decided difference in the cultures; the same pathogenic properties.

Impressed by these resemblances, we have sought for the existence of a closer relationship between these two forms. We have, indeed, found that we can vaccinate against one of these diseases by using the specific microbe of the other.

Thus the pigeon, refractory to the vibriones of Metschnikoff, of which we have already spoken, showed itself possessed with an immunity also for the virus of Asiatic cholera.

On the other hand, every pigeon vaccinated against cholera became at the same time refractory to our vibriones. Here is an experiment which proves this.

The 26th of August ten pigeons vaccinated against cholera\* are, together with a control pigeon, inoculated with one-fourth cubic centimeter of an emulsion made with the blood of a pigeon dead from gastro-enteritis. The control pigeon died the same day; two vaccinated pigeons succumb during the night; the eight others were unaffected. Thus we may conclude that our microbes are very closely allied to the Asiatic cholera vibriones. We can not imagine a more natural explanation of all their common properties than that which considers them as two physiological varieties of the same microbe.†

The one, attacking man, especially, is capable of being produced only in India, thanks, perhaps, to passage through some indigenous animal; the other exists in European countries.

On the other hand, it is possible that our microbes may be allied to diseases of man, such as *cholera nostras* and summer diarrhœa of children. Here is a fact which speaks strongly in favor of this relationship:

The 16th of August Dr. Silouianoff kindly gave us the dejecta from a man attacked with *cholera nostras*. The dejecta consisted of a greyish fluid filled with rice-like flakes, formed of exfoliated epithelium. We fed a young chicken with this fluid, which succumbed to it three days later, with every symptom of choleraic gastro-enteritis. In its windpipe, intestines, and blood were found the characteristic vibriones of this disease. These vibriones were of only weak virulence, while the blood of a chicken inoculated into the pectoral muscles of a pigeon and peritoneum of a guinea pig gave to them only a transient malaise (in the guinea pig the temperature fell as low as 33° C.); but this malaise was followed by a complete immunity against the virulent virus obtained from the blood of a carrier pigeon the 25th of August.

This positive result which I have obtained should, I think, have much greater value than the negative results obtained by Messrs. Koch and Franck, who found no specific organism in several cases of *cholera nostras*; and that for two principal reasons.

(1) Both of these authors in their researches made use of methods of culture, which are incontestably inferior to the method by infection, where one has to do with the discovery of an organism which is lost among the surrounding bacteria. We have already proven this inferiority for several diseases, as fibrinous pneumonia, chicken cholera and anthrax.

Now, we have every reason to believe that by utilizing our experimental method with a young chicken one would attain better results.

(2) We have also shown in our article on pneumonia that the pathogenic microbes, after having produced the specific lesion, can disappear in order to be replaced by surrounding saprophytic bacteria. In the case of *cholera nostras*, which is a benign malady, this disappearance of the pathogenic vibriones is very probable, in view of the formidable emigration of leucocytes, which we have demonstrated in the intestinal canal after infection of pigeons and guinea pigs with the slightly virulent vibriones of Metschnikoff.

These two orders of considerations force us to conclude that the whole etiology of *cholera nostras* is to be reformed upon our experimental data.

\*See Comptes rend. de l'Acad. des Sciences, 20 août, 1888.

†Asiatic cholera vibriones are distinguished by their greater faculty of forming spores,



## ON THE DIARRHÆIC ACTION OF CHOLERA CULTURES.

By N. GAMALEÏA, of Odessa.\*

In our method of preventive vaccination against cholera we sterilize the vaccine culture by heat at 120° C. This high temperature is necessary, not in order to kill the microbes of cholera which perish at a much lower heat, say from 55° to 60° C., but in order to surely destroy the specific products which are generated during development—products which we call diastases, the study of which forms the object of this communication. These diastasic substances only hinder the vaccination of guinea-pigs by chemical substances. While, on the one hand, the vaccine heated to 120° C. produces only local œdemas, which are very quickly absorbed; the bouillon cultures sterilized at a lower degree give origin to indurations, which are persistent, and the animals do not recover so quickly as with our vaccine heated to 120° C., whilst at the same time the acquisition of immunity is retarded, if not completely prevented. Furthermore, these diastasic substances, harmful to the vaccination, are not without importance in the etiology of cholera, for they allow the experimental reproduction of the clineal form of the disease. This experimental reproduction was unrealizable up to this time, at least with cultures of the microbe of Koch. With the urine of persons attacked with cholera, Bouchard has given a choleriform affection to rabbits. This last fact leads us to set forth here the results of our researches made upon the same animal, which are interesting from still another stand point.

Firstly, all the experimenters have demonstrated the complete immunity of rabbits to infection by the cholera microbes. Secondly, these animals are very resistant to the toxic action of even our virus. In fact, rabbits stand as much as 80 cubic centimeters per kilogram of weight of our virus injected into the veins. In stronger doses death arrives immediately, preceded by muscular tremblings, convulsions, and exophthalmia.

The maximum of toxic action is seen at the moment of injection, and the animals which survive this stage recover very quickly. The vaccine cultures which are non-sterilized also provoke similar phenomena.

Only immediate death is brought about by doses much smaller, and the animals which have succumbed present considerable quantities of cholera microbes in their blood. But here, with doses which do not produce immediate death, we meet with other phenomena. The injection of 10 cubic centimeters per kilogram of weight induces progressive asthenia and cyanosis of the animal, and very pronounced lesions of the intestines are found at the autopsy. The explanation of the lesions is furnished by the effects of cholera cultures sterilized at 60° C. These cultures are very toxic for the rabbit. Quantities above 10 cubic centimeters per kilogram of weight rapidly produce death. The morbid phenomena begin by shiverings and spinal epilepsy, to which succeed a complete prostration, terminated by death, which is preceded by a few clonic convulsions of the anterior paws.

More characteristic are the phenomena observed with doses still smaller, say 5 to 10 cubic centimeters. Then the asthenia of the animal is not so complete. They refuse all solid nourishment, but lap with avidity fluids which are found in their neighborhood. About an hour after the injection diarrhœa supervenes, the alvine dejections, at first consistent, become completely fluid. This diarrhœa may last for several hours, and recur again with intermittences several times, when it ceases. The prostration, thirst, and want of appetite persist. At the same time one often sees the cornea become clouded and gray. This opacity disappears later if the animals recover. In the latter case the excretion of urine, which up to that point was suppressed, begins again, but the urine contains albumen. The animals return only with difficulty to their normal condition. For a long time they remain very much predisposed to the choleraic infection. In reserving to ourselves the right to speak again concerning this predisposition, which in itself presents a close analogy to human cholera with its microbes in the fluid stools, we will add here that the diarrhœic action of our culture is suppressed by heating to 70°

\* *Comptes rendus de l'Acad. des Sci.* No. 12, 1890.

C. On the other hand this action persists in the solutions of the substances precipitated from our culture by alcohol.

We do not emphasize the general bearing of our researches, which establish the distinction between the vaccine matters and morbidic substances.

Mr. Bouchard, who presented this communication to the French Academy, added the following reflections thereon:

This communication of Mr. Gamaleïa reminds me of certain facts which I demonstrated in 1884, when I injected into rabbits the urine of patients suffering with cholera. It produced cyanosis, muscular tremblings, diarrhœa with intestinal desquamation and albumen uria which Gamaleïa has also obtained by injections of cultures of the comma bacillus of Koch or of the chemical products of this microbe. But I ought to say that I have never obtained these phenomena in rabbits by injecting cultures of the comma bacillus, either sterilized or non-sterilized, and yet I have pushed these injections as far as 40 cubic centimeters per kilogram of weight of the animal, and even higher.

With respect to the toxic rôle which may belong to the diastases, it follows from the experiments of Gamaleïa, as it has already resulted from the researches of Arloing, Christmas, Rossy, Roux, and Yersin. The experiments of Gamaleïa have from this point of view a special interest. They will demonstrate that the vaccinant power belongs not to the diastasic substances, to which appertain a part, at least, of the toxic power. This fact follows from the researches which have been undertaken for some time in my laboratory by Messrs. Arnaud and Charrin upon the soluble products of the bacillus pyocyaneus. These experimenters have demonstrated that if one distills the cultures of this bacillus, the fluid of distillation is not toxic, but it is vaccinant. The dry residue is at the same time toxic and vaccinant. That the diastasic matter precipitated from the culture by alcohol and washed in alcohol, then re-dissolved in water—matter which does not produce sugar from starch and does not liquify gelatine, but which transforms cane sugar into glucose—has a morbidic power, but only a very doubtful vaccinant action. Is this not a demonstration of the opinion which I have already advanced before the Academy, not only of the plurality of bacterial substances capable of exercising a physiological action upon animals, but also of a radical difference that exists between the toxic and vaccinant matters?

## SECTION 4.

### CHEMICAL PRODUCTS OF CULTURES OF COMMA BACILLI AND THE DIAGNOSIS OF CHOLERA.

#### *A CHEMICAL FERMENT SECRETED BY KOCH'S COMMA BACILLUS OF CHOLERA, ETC.*

By H. BITTER.\*

The author, under direction of H. Buchner, showed that peptone-beef-bouillon, which had served for the development of pure cultures of the comma bacillus of Koch, has even after death of the specific bacteria (by heating a half hour at 60° C.) the property of peptonizing. Portions of such a sterilized solution added to sterilized 10 per cent. gelatine culture media, so alter the latter after 24 hours action at 37° C. that no coagulation takes place at 0° C., in ice water. The gelatine in such media was, therefore, completely converted into gelatine-peptone.

Thus for the first time is the proof furnished that a bacterial ferment, analagous to the ferments of the higher organisms, is also elaborated by these minute cells and is made known by its chemical effects. The comma bacillus of Koch elaborates not only a peptonizing but also a diastasing ferment.

According to the experiments of this author, the Finckler-Prior comma bacillus also possesses the same ferment-producing quality as does the Koch bacillus. The known differences

\* Ueber Fermentausscheidung von *Vibrio* Koch (Kochscher Comma-Bacillus der Cholera Asiatica) und *Vibrio* Proteus (Finckler-Priorscher Komma-Bacillus der Cholera Nostras).—Inaug. Diss. München, 1886, und Archive für Hygiene, Band 5, 1886, H. 2.



of growth in gelatine media of these two organisms are due, according to the author, to the difference of activity of movement of the respective microbes, the Finckler bacillus being much more motile than that of Koch.

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LIQUEFACTION OF GELATINE BY BACTERIA.

By GEORGE M. STERNBERG.\*

One character which is common to quite a number of micro-organisms, and which Koch was quick to seize upon as of value in defining specific characters, relates to the power of liquefying gelatine.

So far as the writer is aware, no satisfactory explanation of the cause of the liquefaction has been given, although it is evidently connected in some way with the growth of the liquefying organism.

In the course of my recent experiments upon the thermal death-point of pathogenic organisms I have ascertained that this liquefaction is due to a soluble chemical product which is formed during the active growth of the liquefying organism, and that an apparently small amount of this substance will liquefy gelatine quite independently of the living organism. This is shown by destroying the organism in liquefying gelatine culture by heat, and then adding a small amount of the culture to flesh-peptone gelatine which has been rendered fluid by gentle heat; upon placing the gelatine aside in a cool place, it will be found that it has lost its capacity for becoming solid.

Into capillary tubes, having an expanded end to serve as an air chamber, I introduced about one-tenth cubic centimeter of an old culture of each of the following organisms: *Bacillus prodigiosus*, *B. indicus*, *B. pyocyaneus* (green pus), and Finkler-Prior's spirillum. The extremities of the glass tubes were then sealed by heat, and they were placed in a water-bath maintained at 80° C. (=176° F.) for ten minutes. My previous experiments had shown that a temperature considerably lower than this insures the destruction of all of these organisms. The contents of each of these capillary tubes was then forced into a test-tube containing about 3 cubic centimeters of flesh-peptone gelatine, liquefied by heat. This is accomplished by breaking off the extremity of the capillary tube and gently heating the expanded end containing air. A control-tube containing the same quantity of the same gelatine was placed with these tubes in a cool place. The following day the gelatine in the control-tube was found to be perfectly solid, while that in the other four tubes was entirely fluid.

Having thus shown that liquefaction of the gelatine is due to a chemical product of some kind, produced during the active growth of certain organisms, and that a comparatively small amount of this substance causes liquefaction quite independently of the organism, I trust that some chemist will take up the question with a view to ascertaining the exact nature of this substance.

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BIO-CHEMICAL PROPERTIES OF MICROBES.†

At a meeting of the Russian Chemical Society in St. Petersburg, Prof. A. V. Poehl (Vratch, No. 8, 1886, p. 157) made a very interesting communication on his experimental study of the vital process of various microbes. The formation of ptomaines in nature, he says, is mostly caused by the vital action of micro-organisms. While studying the microbes of human fæces, the author found that in morbid cases there appear in the intestines several kinds of microbes possessing the property of decomposing proteid bodies. To use Hoppe-Seyler's words, the decomposing action of bacteria on proteids resembles that of caustic alkalies (while ferments act on proteids like weak acids). Under the splitting action both of bacteria and caustic alkalies there simultaneously appear the products of oxidation and those of reduction, which

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\* Med. News, April, 1887.

† London Medical Record, December 15, 1886.

fact is explained by decomposition of water ( $H_2O$ ) into an oxidizing hydroxyl ( $HO$ ) and a reducing hydrogen ( $H$ ).

Ptomaines belong to the products of disoxidation. Dr. Poehl succeeded in demonstrating the reducing action of certain micro-organisms on the surrounding nutrient medium during their growth. He recommends taking a neutral nutrient jelly, to which is added .05 per cent. of perchloride of iron and .05 per cent. of red blood salt (ferric potassium cyanate). Micro-organisms endowed with a reducing power give rise to a blue coloration of the jelly (in consequence of formation of Berlin blue), which commences in the lowest part of the track left by an inoculating-needle, but subsequently spreads around in the jelly (since ptomaines, on their being absorbed by the jelly, also deoxidize the latter).

Dr. Poehl examined in that way cholera bacilli brought by Professor Raptchewsky from Spain, typhoid bacilli, Finkler and Prior's bacilli, certain microbes of pus and fæces, as well as microbes of water from the Neva. A quite distinct reduction was obtained from the cholera bacillus, typhoid bacillus, some of the microbes of pus, fæces, and the Neva water, and from "Bienstock's bacterium," No. 4. But Finkler and Prior's microbe of *cholera nostras* gave no reduction, since it does not produce ptomaines (though it freely peptonizes syntonine). Hence the author proposes to use that bio-chemical behavior as a means of distinguishing between Koch's microbe of Asiatic cholera and Finkler-Prior's bacillus of *cholera nostras*. As a rule, micro-organisms liquefying (under ordinary conditions) nutritive jelly do not possess either a reducing power or a power of forming any ptomaines. When present in the intestines the cholera bacillus also produces a reducing action on the surrounding medium and leads to the formation of ptomaines (the presence of which in cholera cases has been actually proved by Klebs, Pouchet, Nicati, and Rie'sch, etc.). The author feels sure that cholera could be usefully treated by the administration of oxidizing remedies, such as chlorinated water, peroxide of hydrogen, salts of permanganic acid, etc.; they are indicated the more strongly, since most of the ptomaines are destroyed by the action of oxidizing agents. [Referring to the therapeutic dictum of Professor Poehl, Professor Manasseïn expresses his doubt that chlorinated water and peroxide of hydrogen taken internally could reach the intestines undecomposed.—Rep.]

#### A CHEMICAL REACTION FOR THE CHOLERA BACTERIA.

By O. BUJWID.\*

The author has discovered a characteristic chemical reaction in cultures of the comma bacillus of Koch. To a ten-hour-old culture of these bacilli in peptone bouillon 5 to 10 per cent. of hydrochloric acid, sulphuric acid, or nitric acid is added. Soon is produced a weak rose-violet tint, whose intensity in the course of the next half hour very much increases.

This reaction (which most closely recalls the peptone reaction with copper and potassium) appears in ten to twelve-hour-old bouillon cultures developed at  $37^{\circ}C$ ., and also in fluid-gelatin cultures, but only after twenty-four hours of growth. *The reaction fails if the culture is impure.* Other bacteria give as far as the quite numerous control experiments of the author go no such reaction. Cultures of the Finkler-Prior bacilli show after similar treatment a brownish color, which appears somewhat later and is much less intense. By use of this new means it may be possible to diagnose the cholera bacilli earlier than can be done by means of the plate cultures alone. Possibly this reaction might be employed directly with the dejecta of suspected cases of cholera.

#### CONCERNING THE PRODUCTION OF CHOLERA-RED.

By L. BRIEGER.†

Professor Brieger, in discussing the so-called cholera-red, thus expresses himself:

Pöhl regards a derivative of skatol, which was isolated by me, as a basis of the red coloration of cholera cultures produced by the addition of mineral acids, a reaction which was first

\* Zeit. f. Hygiene, Band 2, 1887; from Baumgarten's Jahresbericht, zweiter Jahrgang.

† Ueber die Entstehung des Cholera-roths, etc., Deut. Med. Wochenschrift, No. 22, Juni 2, 1887.



discovered by him (Berichte der Deutsche Chemische Gesellschaft, Bd. 19, p. 1162, Jahrg. 1886), the diagnostic value of which Bujwid recently pointed out (Zeitschrift f. Hygiene, von Koch u. Flügge, Bd. II, p. 52, 1887). After I had obtained the cholera-red substance (see this Wochenschrift), I was able to establish very nearly the mode of production of this clinically important chemical body.

The cholera-red, which is to be obtained pure by crystallization from benzole, is, according to my experience, soluble in ether, amyl-alcohol, and chloroform, and its special characteristic is the change which it undergoes into blue coloring matter in an alkaline solution of a certain strength. The latter color, however, may be easily changed again into Burgundian red by the addition of any mineral acid. The blue coloring matter readily disappears in amyl-alcohol, but returns again when allowed to stand.

If the chemically pure cholera-red is distilled in a small tube with zinc-filings (Zincstaub) a white crystalline substance is deposited upon the cold portion of the tube. This substance smells quite like indol, and, when dissolved in water, gives a red color, which is characteristic of indol. From this it follows, therefore, that the cholera-red is a derivative of indol. Cholera cultures which are made in albuminates always contain indol, a fact of which one can be easily convinced by distilling them with acetic acid; the distillate, on account of the acetic acid that goes over with it, is often colored a beautiful violet. If this is treated with fuming nitric acid, the nitroso-indol color then appears. If one searches for the indol in flesh-peptone-gelatine cultures of the cholera bacilli, by distillation with acetic acid, the residue, when treated with concentrated sulphuric acid, gives a faint red. This red color is due, in great part, to the action of sulphuric acid upon the peptone.

#### SIGNIFICANCE OF THE SO-CALLED CHOLERA-RED.

By CHARLES H. ALI-COHEN.\*

According to Charles H. Ali-Cohen, the so-called cholera-red reaction, shown by cultures of the comma bacillus, only appears if the acid employed in the test (whether sulphuric, muriatic, or anthric) contains some *nitrous acid*, and the rapidity of its appearance is dependent to a certain extent upon the amount of  $\text{HNO}_2$  present. Ali-Cohen also claims to have cultivated a bacillus from the spleen of typhoid fever patients, which gives exactly the same reaction with these acids. In view of this discovery he would deny the assumption that the so-called cholera-red is distinctively characteristic of Koch's cholera bacillus.

As a result of a long series of experiments the author arrives at the following conclusions :

(1) The so-called cholera-red appears only with the use of impure mineral acids (containing  $\text{HNO}_2$ ).

(2) The so-called cholera-red is no specific product of Koch's comma bacillus.

(3) Koch's bacilli produce the indol derivative somewhat more quickly than do the morphologically related forms; there is, moreover, a form (probably several) not morphologically related to the Koch bacillus, which is capable of producing the indol derivative quite as rapidly as is the Koch's bacillus.

(4) In the latter the color reaction has no diagnostic significance; probably the reaction may prove to be useful by means of a modified method.

(5) The reaction applied to diarrhoeic discharges has no value in respect of the chemical nature of the coloring principle.

(6) The advice of Bujwid to combine the reaction with plate-culture investigations without awaiting the characteristic growth is to be reprobated.

(7) The already worked-out methods of differential diagnosis by bacteriology only should be followed.

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\* Fortschr. der Med., September, 1887, No. 17.

## CONCERNING "CHOLERA-RED" AND THE CAUSE OF THE CHOLERA REACTION.

By E. SALKOWSKI.\*

The author shows (in opposition to Ali-Cohen) that for the development of the cholera-red reaction absolutely pure sulphuric or hydrochloric acid is necessary; the use of nitric acid and sulphurous acid containing nitrous acid is absolutely to be avoided, because solutions of indol yield with these acids a purple or violet color; they are worthless for the demonstration of the presence of the cholera bacteria.

Nevertheless, the author finds that the cholera reaction is nothing less than a quite common indol reaction, and consequently the explanation of the fact that the indol reaction occurs in cholera cultures even with (pure) sulphuric acid, lies simply in the fact that the comma bacilli constantly produce nitrous acid, which is found in the fluid in the form of nitrites. There is, therefore, no specific cholera-red, as Brieger has believed; this substance is rather a simple indol-red, and is demonstrable in any decomposing peptone solution. The comma bacilli are characteristic only for the simultaneous production of indol and nitrous acid.

In every cholera culture the author was able to demonstrate not only the presence of previously formed indol (in the distillate), but also nitrites were found (in the residue after distillation); a fluid containing these two bodies must consequently yield the indol reaction by the addition of perfectly pure sulphuric acid. One can, therefore, obtain the cholera reaction also with the residue of the distillation of cholera cultures, if to this residue one adds either an equal volume of the distillate, which, in fact, contains the indol, or of a distillate from a similarly decomposed peptone culture, or, finally, of an indol solution of .06 to .1 per 1,000. The decomposed peptone culture likewise yields indol by distillation, but the residue contains no nitrous acid; hence it gives no (cholera) reaction with sulphuric acid.

The question is now raised, whether the cholera reaction loses its diagnostic value since it is based upon the indol reaction. Its value will without doubt diminish, since it no longer has to do with a specific product of the cholera spirilli, but with a combination of two products of decomposition. We should in every case aim to use a pure cholera culture for the inoculation of the peptone solution, otherwise the negative absence of the reaction in no way proves the absence of cholera bacteria, and even a positive result is not fully conclusive, for indol and nitrous acid each can be found in the cultures of different bacteria.

## CHOLERA-RED.

By JOSEPH JODASSOHN.†

The inaugural dissertation of Jodassohn is undoubtedly the most searching which has up to the present time been written concerning the cholera reaction in its bacteriological and practical aspects; it treats of many pertinent questions, and he has also collated the known experiments of different authors upon this subject. (Consult: Poehl, *Berichte. d. deutsch. chem. Gesellsch.* 19, 1162, 1886; Bujwid, *Zeitschr. f. Hygiene*, 1887, I, 52; Brieger, *Deut. med. Wochenschr.*, 15 u. 22, 1887; Dunham, *Zeitschr. f. Hyg.*, 1887, II, 337; Zäselein, *Deut. Med. Zeitg.*, 72, 1887.) According to the former authors the reaction appears with HCL, SO<sub>3</sub>, NO<sub>5</sub>; Bujwid especially recommends HCL, Dunham SO<sub>3</sub>; Brieger has worked principally with SO<sub>3</sub>, as also has Zäselein.

According to Jodassohn's investigations hydrobromic acid, phosphoric acid, and tartaric acid, as well as lactic and oxalic acid, give the reaction. HCL for the following reasons holds the front rank:

(1) It does not change the color of the commonly used culture media, whilst NO<sub>5</sub> gives the yellow coloration, which is known under the name of xantho-protein reaction. SO<sub>3</sub> frequently colors the culture media strongly brown, and can thereby conceal the development of the cholera-red.

\* From Virchow's Archiv., 1887, Bd. 110, *Deut. Med. Zeit.*, 11, 1887.† *Deut. Med.-Zeit.*, 11, 30, 1887.



(2) The HCL has, as will be pointed out later, the greatest, perhaps the only really useful, value as a means of differential diagnosis; on the contrary,  $\text{NO}_3$  gives the earliest complete reaction;  $\text{SO}_3$  the quickest and most energetic.

The author has studied the conditions under which the cholera reaction makes its appearance and has begun with the culture media.

(a) *Culture medium*.—Sterilized reservoir water gives a not inconsiderable growth of the comma bacillus, nevertheless such cultures give no cholera reaction; in a solution similar to Pasteur's the bacilli develop with a little more abundance than in water and give also no cholera red; a considerable growth in pure water and gelatine was to be observed, but no reaction followed; the same was the case with sugar and starch solutions and with meal pap. A slight reaction appeared, but only after some days, in simple veal broth, yet a chemically small quantity of albumen could be demonstrated in it.

Chicken albumen (the part which remains in solution after boiling with water), the fluid of hydrocele, and blood serum, furnished only after some days, a good reaction; in sterilized milk the bacilli grew well, but gave no reaction.

The culture media generally used in the laboratories gave very good, rapid, and early appearing reaction; in flesh-peptone-agar, after 6 to 8 hours, at the temperature of the incubator, not only was the culture portion colored, but the whole of the agar contained in the tube became red; the flesh peptone fucus in flesh peptone gelatine media behaved in a similar manner. If, as Dunham says, a brown instead of a red color appears in these cultures, according to Jodassohn, this depends upon the carbonization of the culture materials by means of  $\text{SO}_3$ , HCL or dilute  $\text{SO}_3$  should therefore be employed. Good results are also to be obtained by use of the solutions of Dunham (sodium carbonate, salt one-half per cent., peptone 1 per cent.). From the foregoing it appears that in culture free of albumen the cholera-red does not form; in media which contain non-peptonized albumen (except milk) the reaction appears late and weak; the author rightly believes in the possibility that the albumen becomes peptonized before it is broken up by the comma bacillus. (This was proven experimentally by H. Bitter. Ueber die Fermentausscheidung des Koch'schen Vibrio der Cholera-asiatica. Archiv f. Hygiene V, 2, '86.)

(b.) *Action of oxygen*.—Although the cholera spirillum needs for its development only a little oxygen, the cholera-red does not form at all in the absence of oxygen, in order to obtain an abundant production of the same, the added oxidizing material must therefore be relatively considerable. Cultures which are covered from the air by means of a layer of oil give even after weeks of growth no cholera-red reaction, although the cultures have grown abundantly; after withdrawing the layer of oil a distinct reaction appears in the course of some time.

(c) *Purity of the culture*.—Bujwid says in his communication: If the culture is not pure, that is, if it contains many other bacilli, the reaction does not succeed. Dunham inoculated culture media with a mixture of human fæces and cholera bacilli; after 5 hours the reaction with  $\text{SO}_3$  made its appearance, but after 24 hours it no longer occurred.

The author had similar experience with the intestinal contents of a guinea-pig which had been inoculated with Koch's comma bacilli. Furthermore, culture media were simultaneously inoculated with cholera bacilli and with others which gave no reaction, and at about the same stage of development both showed during the first days only a very slight or no HCL reaction, a weak  $\text{SO}_3$  reaction, and always a strong  $\text{NO}_3$  reaction. Very interesting experiments were the following: Cultures were sterilized; they gave a very good reaction with all these acids; then they were inoculated with other bacilli which of themselves give no reaction; after 3 days only the  $\text{NO}_3$  is effective, the other acids produce no reaction; this behavior shows that the nitric-acid reaction is based upon other conditions than those for the other two acids, and it is not impossible that different substances may be colored red by the different acids.

#### SIMILAR REACTION OF OTHER BACILLI.

The author tested a large number of bacilli for the cholera-red reaction without result (in the original communication (Breslauer aertzl. Zeitschr.) the species are named). Five species

bacilli behaved very similarly with respect to the acid reaction; these were the Finkler-Prior, the Deneke, the Miller spirillum, the Passet bacillus (*pyogenes foetidus*), and the Emmerich (Naples) bacillus. These in peptone solution kept in the incubator often grow with the  $\text{NO}_3$  a violet reaction already after 18–20 hours;  $\text{HCL}$  grew only after some days a slight red color, or none at all;  $\text{SO}_3$  often failed entirely, or was markedly behind the nitric acid in its action. Old cultures of these bacilli behaved like impure cholera cultures. The “chromogen” of these bacilli, as well as the red coloring material produced by nitric acid, disappear (*lösen sich*) in the Brieger media; first they color them in these solutions, but only with  $\text{NO}_3$ , with the other acids scarcely or not at all; decoloration takes place with alkalies, and the red appears again with acids.

Jodassohn discusses also the analogy between “pyocyanin” and cholera-red, and some other colors which are produced by the action of the micro-organisms.

The conclusions of the author are the following:

(1) Pure cultures of cholera bacilli in culture media containing peptone give with  $\text{HCL}$  a red color after a short time, which up to the present is found in no other species of bacilli.

(2) The same coloration appears after addition of  $\text{NO}_3$  and  $\text{SO}_3$ ; but this reaction is less characteristic, because especially the nitric acid reaction appears after a somewhat longer time of development, and moreover cultures of the spirillum of Finkler-Prior, Deneke, Miller, and of the Naples bacillus, and bacillus *pyogenes foetidus* yield a similar reaction.

(3) The cause of the cholera-red reaction is a substance, according to Brieger's investigations an indol-derivative, which is formed in peptone or albumen cultures, and only in the presence of a considerable amount of oxygen.

(4) Impure cultures of comma spirilli mostly give only the nitric acid reaction.

#### REMARKS OF ZÄSLEIN UPON THE INVESTIGATIONS OF JODASSOHN.

From the foregoing, Zäslein understood that Jodassohn is of the opinion that the nitric acid reaction is due to other conditions than is the reaction of  $\text{HCL}$  or  $\text{SO}_3$ ; the following examples from a series of experiments upon this point may probably contribute to an explanation of these conditions:

I. A 6-day old culture in peptone gelatine, of the Koch comma spirillum, gives with  $\text{HCL}$  no reaction; 6 drops of  $\text{NO}_3$  (6 weeks before, chemically pure, even now free of water, but is observed to fume), gives a brownish red reaction; one having a trace of  $\text{NO}_3$  and  $\text{NO}_2$  (has become yellow and distinctly fumes), gives a red reaction; when these solutions are neutralized, a color material goes over with ether, etc., in the process of distillation.

II. Impure cholera cultures give with 6 drops of  $\text{SO}_3$  a yellow reaction;  $\text{HCL}$  no reaction; 6 drops of  $\text{NO}_3$  a brownish-red reaction; a trace of  $\text{NO}_3$  and  $\text{NO}_2$ , a beautiful red reaction. This culture, distilled with acetic acid, gives a colorless distillate which colors with  $\text{HCL}$  not at all; with  $\text{SO}_3$ , a scarcely visible reddish yellow; 6 drops of  $\text{NO}_3$ , a slight red-yellow; a trace of  $\text{NO}_3$  and  $\text{NO}_2$ , an intense and very beautiful red-violet.

III. Pure cholera cultures (24 hours old) become with  $\text{HCL}$  violet-red; 6 drops  $\text{NO}_3$  and  $\text{NO}_2$ , orange, then decolors; a trace of  $\text{NO}_3$  and  $\text{NO}_2$ , violet-red; 6 drops of  $\text{NO}_3$ , violet-red.

It seems to be shown by these experiments that cultures (Deneke's spirillum and impure cholera cultures) which give a reddish brown reaction with  $\text{NO}_3$  and none at all with  $\text{HCL}$ , as well as the pure cholera cultures which give the violet reaction with  $\text{HCL}$ , all give a distinct red or red-violet color with a trace of  $\text{NO}_3$  and  $\text{NO}_2$ ; now, since the reaction with a trace of  $\text{NO}_3$  appears constantly in greatly diluted cultures, I may raise the question, whether the so-called nitric acid reaction, at least in all except the cholera cultures, has to do in reality with the presence of a trace of  $\text{NO}_3$  and not with  $\text{NO}_2$ ; in favor of this assumption is the circumstance that the reaction is always more distinct and intense with the trace of  $\text{NO}_3$  (except in pure cholera cultures) than with 6 drops of  $\text{NO}_3$ .  $\text{NO}_3$  should therefore be entirely eschewed, as also  $\text{SO}_3$ , which not infrequently contains  $\text{NO}_3$  as an impurity.



## SECTION 5.

## CADAVERIC POISONS, PTOMAINE LEUCOMAINES.

## ALKALOIDS OF CADAVERS.

In the last decade a class of bodies has attracted the attention of physicians and chemists which under the name of cadaver alkaloids or "ptomaines" (from *πτῶμε*, corpse) were indeed for a long time recognized, but of whose composition as good as nothing was known, and of their properties we were acquainted only with the poisonous effects. These bodies are produced by the putrefaction of albumen, meat, gelatine, etc., following the decomposing action of micro-organisms, and are often met with in medico-legal investigations of portions of cadavers which have already undergone putrefaction. The alkaloids of putrefaction resemble those of vegetable origin in their most common reactions, and it is therefore important to obtain a very exact knowledge of their properties and reactions in order to distinguish them with certainty during life from poisons criminally administered for the purpose of medico-legal chemical investigations.

The fact that cadavers possess poisonous properties was observed by Gaspart and Stick in 1822; this was, however, forgotten until 1856, when it was again brought to light by Panum.

Following the communication of Panum further investigation of the matter was excited through the offering of prizes by several German universities. In the course of time there appeared various works upon this subject, which, however, solely demonstrated that alkaloid substances of poisonous action originate in the putrefaction processes; by no one was an experiment performed through which the substance itself was isolated and its properties studied. Later investigators busied themselves with obtaining preparations in the form of extracts, proving the physiological action of these substances upon the animal body, as also establishing their behavior towards the commonly used alkaloid reagents. From the statements of different investigators concerning the physiological action of these substances upon the animal organism one perceives a marked correspondence of action with those of the known vegetable alkaloids. The ptomaine which Panum obtained was from its action comparable with snake poison and curare, and it excited active inflammation of the mucous membrane of the small intestine. Bergmann and Schmeideberg obtained from putrefying meat a small quantity of a crystalline substance, which they named *sepsine*, and which was decidedly poisonous for dogs and frogs.

Zeuler and Sonnenschein obtained from putrefying meat infusions a substance which behaved like atropine in that it widened the pupil, paralyzed the musculature of the intestines, and occasioned increase of the heart activity. Rörsch Fassbender isolated a body which in its characteristics resembled digitalin. Schwanert found in medico-legal chemical investigations of portions of cadavers large quantities of an oil which presented the odor of pyropylamine. Various other investigators discovered a volatile alkaloid of an odor and reaction similar to conium.

The distinguished deceased Italian, Selmi, took the most prominent part in investigating the alkaloids of putrefaction, and from him the term "cadaver alkaloid" originated. He was the first who sought to classify these substances and to distinguish them as regards the procedures customarily used in medico-legal investigations for the separation of similar bases—ptomaines: (1) Which through solution in ether were extracted from acid solutions, or (2) from alkaline solutions; (3) those which were extracted from alkaline solutions by chloroform; (4) those taken up by amyl alcohol, and (5) those which were extracted by none of the known solvents. He obtained substances which as respects their reactions and effects might be confounded with morphia, conium, atropine, and delphinine. Brugnatelli, Zanoni, and Cortez discovered in decomposed maize (Indian corn) an antidote to narcotic poisons and another base similar to strychnine.

Various other authors have extracted sirupy substances from putrid material which exhibited toxic qualities, and which therefore were proclaimed as ptomaines; but such deductions can as well be applied to peptone, salammoniac, etc., which injected subcutaneously also act as poisons. These observations therefore possess only a certain relative value.

The first one who described a basic product of putrefaction as a chemical entity was Nencki. He obtained in the putrefaction of gelatine a base which he recognized as collidine ( $C_8H_{11}N$ ). Similar ptomaines were also isolated in a pure crystalline condition by Gautier and Etard. They obtained besides collidin hydro-collidine ( $C_8H_{13}N$ ) and parvolin ( $C_9H_{13}N$ ). These bodies belong to a series of bases which are grouped under the name of pyridin bases. (See *Naturforsch.*, 19, 33.)

Gareschi and Mosso obtained from the putrefaction of fibrine a base of the composition  $C_{10}H_{15}N$ , which very probably belongs to the class of pyridin bases.

G. Pouchet isolated several acids containing (sauerstoffhaltige) bases which according to Gautier's views respecting their composition appeared to be nearly related to the oxybetaines.

Especially to L. Brieger is recently due the service of having thrown light upon the ptomaine question through careful isolation in their purity, and analysis of the different putrefaction products and of having incited further investigations through the working out of special methods of preparation and purification of these alkaloids. He demonstrated that in the first stages of putrefaction certain ptomaines appeared, which in the further course of the process gave place to others. The fact that in the slowly progressive putrefaction of human organs the presence of a strongly poisonous ptomaine during the first day can not be accepted as true. The ptomaines isolated by Brieger are the following: Cholin ( $C_5H_{15}NO_2$ ); Neuridin ( $C_5H_{11}N_2$ ); cadaverin ( $C_6H_{16}N_2$ ); putrescin ( $C_4H_{12}N_2$ ); saprin ( $C_5H_{16}N_2$ ); trimethylamin ( $C_3H_9N_3$ ); mydalëin, of yet unknown constitution.

Cholin and trimethylamin in large doses show a toxic effect (the first similar to muscarin); mydalëin is a markedly poisonous substance of quite specific effect; neuridin, cadaverin, putrescin, saprin are indifferent in their physiological action. In the first days of putrefaction the cholin makes its appearance; afterwards neuridin and trimethylamin, whilst the cholin gradually disappears; later cadaverin and putrescin are found and further on saprin. Mydalëin and another likewise toxic base, but not sufficiently studied, appear not earlier than the seventh, but generally after the fourteenth, day from the commencement of decomposition. Cadaverin and saprin possess a similar chemical composition, but differ from each other in their properties. Brieger believes that all these bases stand in close relation with the diamin of the fat series.

Besides the above-mentioned putrefaction alkaloids still various other basic products occur, although in so small quantity that Brieger did not obtain sufficient for an exact investigation of their composition.

Brieger found that by a little access of acid, as also by frequent stirring of the mass of decomposing material, large quantities of the ptomaines would be obtained, which is against the view of Pasteur that the ferment-producing quality of micro-organisms that multiply by budding or fission become greatly curtailed by the presence of free acid. Moreover, this view of Pasteur is opposed also on other sides. This observation concords with the previous investigation of Brieger, wherein a more rapid and abundant production of indol and phenol was observed when there was a free access of air than when the latter was excluded. Besides it appears as if with little access of air only slightly toxic or non-toxic alkaloids are produced, whilst on the contrary with freer supplies of air poisonous ptomaines are formed.

In order to solve the medico-legal-chemical question of the possibility of the confusion of the ptomaines with poisonous alkaloids of vegetable origin, the Italian Government appointed a commission charged with the testing of this matter and published the results of their investigations in 1885. Marion Zuco, who had charge of the experimental part of this work, states that by following the usual medico-legal methods he could obtain from buried corpses only two ptomaines, one of which he identified as cholin proceeding from the decomposition of leucythin, whilst the other possesses the marked characteristics of an ammonium hydroxid base with



several alcohol radicals. Hence a confusion with the customary vegetable alcohols as far as the chemical processes followed in this investigation is concerned is not to be feared. By many, including Gautier, reagents have been recommended which give a characteristic color reaction with the ptomaines and not with the vegetable alkaloids, but Brieger has proven that these reactions as a rule indicate impurities and that therefore the reagents do not possess the value ascribed to them.

Not only from the stand-point of medico-legal experimentation does experimentation concerning ptomaines attain a great importance, but it may be capable of throwing much light upon the subject of infectious diseases which is still so dark. Thus indeed the abnormal occurrences in the treatment of wounds as also the characteristic symptoms of poisoning which develop after ingestion of spoiled food (sausage-poisoning, cheese-poisoning), without doubt are to be set down to the action of a special ptomaine which arises from the connective tissue substances through the decomposing action of micro-organisms.

Hence it is to be expected that the micro-organisms which cause reaction and the appearance of a special disease may produce a special ptomaine. Following this thought Brieger has isolated and cultivated and examined the by-products of various bacteria. In cultures of the typhoid bacillus he obtained as products alcohol, lactic acid of ferment, and a poisonous ptomaine, and he also secured a non-poisonous ptomaine from a culture of a staphylococcus which he regarded as a product of these micro-organisms.

These investigations which indeed have scarcely only yet begun, warrant us in looking forward to the discovery of far more interesting facts. For it is already known that certain micro-organisms have their activity arrested through accumulation of their products, and such investigations may eventually place us in possession of a knowledge of the means of controlling these destroyers of human health. Of what medical science has to expect from these investigations the experiments by Pasteur, Toussaint, Chauveau, etc., which have already given brilliant results, eloquently speak. (Ueber Ptomaine von Prof. Dr. L. Brieger. Weitere Untersuchungen über Ptomaine von demselben, Berlin, 1885.) (Sur les Alkaloides dérivés de la destruction bactérienne ou physiologique des tissus animaux. Ptomaines et Leucomaines par E. J. Armand Gautier Par., 1886.)

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#### PTOMAINES.\*

Brieger has obtained from the cadaver the following ptomaines: Cadaverin putrescin, a base similar to curara in its action, and called midatoxin and mydin. From the flesh of the horse he found cadâverin putrescin, a feebly acid, toxic substance of the composition midatoxin and methyal guanidin. In putrid fish he found cadaverin putrescin methylamin, dumethylamin, trimethylamin, diethylamin, and neuridin, which produces curara-like symptoms; also a non-poisonous base, betain. From cultures of the Eberth's typhoid bacillus Brieger separated typhotoxin. This ptomaine produces in the lower animals lethargy or stupor, with diarrhea. With cultures of the tetanus germ (of Flügge, Niedlaier, and Rosenbach) was formed a base ( $C_{13}H_{30}N_2O_4$ ) which produces the same symptoms as inoculations with the germ do.

Professor Marino-Zuecco embodies his researches on ptomaines on the report of the Royal Italian commission for the ascertaining of specific tests in cases of poisoning. He obtained from fresh eggs, blood, brain, liver, etc., by the method of Stas, as well as that of Dragendorff, relative quantities of a base which gave alkaloidal reactions; but that in all cases was found to be neurin. He proved that this base did not pre-exist in the organs, but was formed by the action of acids upon the lecithin contained in them and not from the albumenoids present. Neurin can mask the reaction of vegetable alkalies, such as strychnine, and hence it is necessary to separate it before making the usual test. This is done by taking up the extract obtained by either method in acidulated water, reprecipitating with ammonia, and extracting again with ether of chloroform. Neurin is insoluble in the solvents, and by repeating the operation several

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\* From the Journal of Analytical Chemistry. Polyclinic. May, 1887.

times may thus be completely removed from any vegetable alkalies which may be present. Larger quantities of neurin are obtained by Dragendorff's methods than by that of Stas, but this is not had by a difference in the action of the acids employed, but is dependent upon the amount of extractive matter in which the neurin is soluble. This amount is much greater with the former method than with the latter.

From the liver and spleen he obtained in addition to neurin another base, the hydrocolor solution of which exhibited a beautiful violet fluorescence, similar to that of the salts of quinine. Unlike neurin, it is soluble in the re-agents employed, and the fluorescence increases on the addition of sulphuric acid; with general re-agents it behaved the same as quinine, but did not give the characteristic green coloration produced by the quinine on addition of chlorine water and ammonia, and instead gave a white precipitate. This substance is the same as "animal chonoidin," discovered by Benze, Jones, and Dupre.

Experiments made on various organs of decomposing cadavers yielded a base which was apparently the same from all, and from its behavior to solvents appeared to be neurin. Minute traces of other alkaloids were obtained. Under the conditions that a toxicologist works, these cadaveric alkaloids are not found in appreciable quantity, and can be separated from vegetable alkaloids by the method given above.

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#### ANIMAL ALKALOIDS OR LEUCOMAINES.\*

M. Gautier analyzed the saliva of snakes, four-footed animals, and human beings. Here also he found alkaloid poisons of varied character. Further diligent search and untiring study revealed the startling fact that the human organism and certain other of the beings also in the scale of creation were continually manufacturing alkaloid poisons. These he called the leucomaines. Every animal organism so long as it lives produces leucomaines differing in each other in their chemistry and physiological effects. Now, in ordinary cases in animal health the production of the alkaloids in the organs is so small and their elimination from the system so irregular that no harm arises from the effects. Life is a continual process of partial death. Each tissue of the body and brain is renewed without ceasing; the alkaloids or leucomaines produced by such death being either got rid of by internal combustion in contact with the blood or by elimination of the organs of secretion and excretion and to give play to the fatal elements. It is consequently evident that should this regular combustion or elimination be arrested, hindered, or delayed the renewal of the tissues must be equally so; thus self-poisoning or auto-infection occurs. Thus a man sets the brain cells in motion, a certain amount of wear and tear is caused, and an alkaloid called nervine is formed, which, if accumulated, becomes highly injurious. It is the same with regard to bodily diseases generally.

Now, the theory of auto-infection by accumulated leucomaines has many arguments in its favor; this is very important and accounts for many hitherto inexplicable causes of isolated and epidemic diseases. Without a doubt the whole question not only interests the physiologists and biochemists, it will set the whole educated world thinking. Meanwhile the work of discovery and classification goes on apace, and now that we have been told the physiological significance of animal alkaloids in health and disease we may hope to hear something of the best methods of preventing their over accumulation in the system and how to battle with the dire effects of the hidden ptomaines and leucomaines.

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#### POISONOUS ALKALOIDS OF URINE.†

The poisonous character of normal urine has been pointed out by Bouchard and Pouchet, and a contribution to the *Repertoire de Pharmacie*, by M. Villiers, gives the results of a renewed study of the subject. M. Villiers declares that alkaloids only exist in the abnormal

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\* Medical Press, 6-8, 1887.

\* Editorial in the Lancet, July 25, 1885.



urines. That normal urine had toxic characteristics has been asserted for many years, but the particular constituent on which the poisonous characteristics depend have been variously conjectured. Some said it was the potash salts, others attributing the blame to urea. Pouchet in 1880 found an alkaloid in normal urine. Bouchard has shown that alkaloids are formed in the body even in health. They appear in the intestines as the result of the action of vegetable organisms, are absorbed into the blood, and thus appear in the urine. Our readers will remember the suggestion made by Dr. Lauder Brunton as to the explanation of some of the distant symptoms of indigestion through the agency of alkaloids formed in the alimentary tract during digestion (*vide* The Lancet, January 10, and 24, and February 7, 1885). Bouchard injected normal urine into the veins of a rabbit, and observed the following phenomena: Contraction of pupils, slow respiration, muscular weakness, lowered temperature, abolition of reflexes, and torpor, followed by death, which was due to respiratory paralysis. Bouchard found that to produce a fatal result required much more urea than was contained in a fatal dose of urine. Uric acid and extractive matters proved to be harmless, or nearly so. The same quantity of the potash salts contained in the fatal dose of urine was insufficient to cause the effects. Decoloration of the urine by animal charcoal also deprived it of half its toxic power. That the poisonous agent is not volatile is shown by the circumstance that boiling does not destroy its power. An extract of urine also contains the poison, which, however, does not exert any myositic action, though it possesses sealogogue properties. This alkaloidal sialogogue has been extracted also from muscle, liver, urine, and blood, though its proportion in urine is but small.

M. Villiers has made three series of experiments—the first on himself, the second on a certain number of individuals in good health, and the third on a patient suffering from various illnesses. Five observations made on the urine discharged by himself in a normal state of health gave five negative results so far as the detection of an alkaloid was concerned. On the other hand, the same method of investigation made on two occasions, when M. Villiers was indisposed (once with slight bronchitis and once in a feverish attack) showed the presence of alkaloids in the urine. The urine of nine individuals apparently in a good state of health were found on examination to be free from alkaloids in seven cases and to contain them in two cases. M. Villiers is of the opinion that any deviation from a normal condition, however slight, may be attended with the passage of alkaloids in the urine. If very large quantities of urine be experimented on, he states that he would not be surprised if alkaloids should be found. Further, a mixture of apparently normal urines would probably furnish alkaloids. He objects to M. Pouchet's results, because they were derived from an examination of very large quantities of mixed urines (*i. e.*, taken from more than one individual. M. Villiers has detected alkaloids in the urine of individuals suffering from measles, diphtheria, pneumonia, phthisis, and cephalic abscess. M. Bouchard has found them also in the urine in typhoid fever. More recently Lépine and Guérin have shown that various acute diseases, such as typhoid fever and pneumonia, are attended with what they regard as an increased urinary discharge of alkaloids. The urine in diabetes, catarrhal jaundice, cirrhosis with jaundice, and in alcoholic cirrhosis with jaundice did not show any increase. The ascitic and pleuritic fluids in a case of alcoholic cirrhosis, the fluids in a case of Addison's disease, and the peritoneal fluid in chronic peritonitis did not yield any excess of alkaloids. The alkaloid of pneumonia arrests the heart in systole; that of typhoid fever, in diastole.

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#### ALKALOIDS IN DISORDERS OF DIGESTION.

T. LAUDER BRUNTON (Disorders of Digestion, London, 1886) is of the opinion that there is positive evidence of a formation of alkaloids in the intestine, afforded by the fact that they are found in fresh voided fæces.

That alkaloids are present in the circulating blood is shown by the fact that they are separated from it by the kidneys and are found in the urine. Bouchard considers that the alkaloids formed in the intestine of a healthy man in 24 hours would be quite sufficient to kill him if they were all absorbed and excretion stopped. There seems to be little doubt that the amount of ptomaines formed in the body in disease is greater than it is in health, and very probably they are of a different character, possibly varying with the disease. According to Lépine and Guérin, the poisons contained in the urine in different diseases differ in their physiological action.

It is probable that microbe is the cause of cholera, but the symptom occurring in the disease is probably due to the action on the tissues of a poison generated by the microbe, and not of the microbe itself, just as intoxication is due to the alcohol produced by the yeast-plant, and not to the action of the plant itself, on the nervous system and blood.

No alkaloid having a well characterized chemical formula appears as yet to have been isolated from cholera stools, but Nicati and Rietsch have produced choleraic symptoms in animals by cultivations of the comma bacillus from which the bacilli themselves had been removed, and somewhat similar results were obtained several years ago by Lewis and Douglas Cunningham with cholera stools in which any organisms present had been destroyed by boiling.

#### *VARIATIONS IN QUANTITY OF SPECIFIC ALKALOIDS OF PLANTS.*

PROFESSOR A. VÖGEL has observed that plants do not always contain their characteristic alkaloids when grown under other than natural conditions. Hemlock does not yield conine in Scotland, and cinchona plants are nearly free from quinine when grown in hot-houses. Tannin is found in the greatest quantities in trees which have had a full supply of direct sunlight.

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#### *ACTION OF CERTAIN SUBSTANCES UPON THE PRODUCTS OF SECRETION OF MICROBES.*

By MM. ROGER and CHARRIN.\*

According to MM. Roger and Charrin, there exist sufficient and numerous conditions in which a chromogeneous microbe may develop without giving rise to the coloring matter which it habitually produces. This may be easily observed in cultures of the procyanogen microbe and in those of a bacillus which we have found in the intestine of the rabbit, and which secretes a green fluorescent substance. These microbes develop without producing pigment when they are cultivated in confined air or in pure oxygen. A number of antiseptic substances added to the bouillon have a similar effect. They have studied, especially from this point of view, the influence of corrosive sublimate and of the black sulphide of mercury. The latter salt prevents the appearance of coloring matter, in the proportion of 5 grammes to the liter. It does not in any way disturb development, even when in very considerable proportions (100 grammes per liter). The corrosive sublimate arrests the production of coloring matter in a dose of .3 grammes per liter, and arrests development in a proportion of .4; efficient doses of this substance vary, however, according to the varying conditions of the experiments. In all these cases no chemical action upon the pigment is in question, but a veritable modification in the functions of the microbe.

According to M. Charrin, some of the facts which MM. Roger and Charrin have just reported will doubtless not surprise bacteriologists accustomed to examine chromogeneous microbes. They nevertheless pointed them out, because it appeared to them that these facts, besides being purely biological, have a real theoretical and therapeutic antiseptic importance of considerable interest.

It is known by every one that when one employs an antiseptic the first thought is to avoid destroying the patient while killing the microbe. It follows from the experiments of Bouchard

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\* La Semaine Med., 11, 2, 1887.



concerning naphthol (*Académie des Sciences*; 25 October, 1887), and it results also from the new experiments which we shall adduce, that, in a general way, beginning with the minimum dose of an antiseptic capable of destroying the life of a micro-organism, one can diminish this dose by a third, often by a half, and consequently diminish by that much, the noxious action which the antiseptic employed may have upon a patient, still maintaining with it, however, a considerable influence upon the bacteria combated. Now, notwithstanding this diminution of dose, according to the species of the microbes, one more or less curtails their number, their quality, and, according to the media, their life itself, their development, and their functions, for it is well known that in order to produce an infectious disease it does not suffice to introduce into a living body a pathogenic agent; it is still further necessary that this agent may be capable of developing there and performing its functions, since the rôle of the products of microbes is now admitted to a certain extent. A simple retardation in the development of the functions—a retardation which may be brought about by antiseptics—will at times, as clinical experience has demonstrated, prove beneficial to the patient.

Antiseptic therapeutics in medicine, imperfect as it still is, should, therefore, aim not only to kill the parasite—which evidently is an end most desirable—but it ought equally to undertake to combat the multiplication of them, or at least antagonize the activity of their functions.

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#### *INFLUENCE OF VARYING TEMPERATURES UPON THE VITALITY AND VIRULENCE OF THE CHOLERA VIRUS.*

By CATTANI, of Bologna.\*

Cattani, of Bologna, experimented concerning this subject with pure cultures of comma bacillus (in agar-agar, as also in peptone broth), at a temperature of 35° C., at the ordinary temperature of the surrounding air, or exposed for a certain time to a temperature below the freezing point. The results were as follows:

(1) The comma bacilli of Asiatic cholera, at a temperature of 35° C. and often transplanted, quite or almost entirely preserved their power of development, as also their morphological and pathological characteristics, even for a year after their removal from cholera patients.

(2) At a temperature of 35° C., old comma bacilli (bouillon cultures) can often occasion positive results, with an exuberant development, after they have reached an age of 7 to 8 months.

(3) On the contrary, cultures of comma bacilli which were exposed to the changes of the surrounding atmosphere soon lost their power of growth, and, after 3 months, no longer gave any positive results.

(4) The comma bacilli retained their vegetative power almost unaltered when kept at the freezing point for 5 to 11 days. The power of development began to weaken only after 14 to 16 days, and finally disappeared. Of some hygienic interest is the fact that cultures exposed from 16 to 44 days to a temperature at the freezing point may again revive their lost vegetative power when they are subjected from 15 to 20 days to a temperature of 35° C.

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### SECTION 6.

#### CHOLERA ALKALOIDS OR PTOMAINES.

Since the commencement of the scientific investigations of the recent epidemic of cholera numerous more or less successful attempts have been made to find a specific chemical product in the culture media in which certain specific microbes have been developed, and the comma bacillus of Koch has been subjected to examinations of this character. Investigators have

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\* *Deut. Med. Zeit.*, 11, 28, 1887.

reported conflicting results, either of positive, negative, or indefinite character. The principal reports relating to this important subject that have been published will appear below.

Among those who are impressed with the belief that the comma bacillus of Koch constitutes the genuine specific cause of cholera the great majority, including Koch himself, are also of the opinion that it is not through the direct mechanical action of the microbe itself that the disease is produced, but through the agency of a specific alkaloid, or ptomaine, which is produced in the course of development and growth of the microbe; that this ptomaine constitutes a virulent poison, which, absorbed into the blood, reaches the various parts of the body and occasions the various symptoms which characterize the disease.

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*INGESTION OF CHOLERA DISCHARGES BY MAN.*

BY BOCHEFONTAINE.\*

It is generally admitted that the contagium of epidemic diseases enters the human organism by way of the alimentary canal chiefly with the liquid or solid food. It is further believed that the infectious germ of cholera resides in the alvine evacuations of cholera patients under the form of a comma bacillus recently studied by Koch.

Numerous experiments have been performed upon animals with the object of producing in them the choleraic disease by means of the rice-water discharges of cholera. These experiments have not furnished absolutely demonstrative results. So I promised myself to seize the first occasion which offered, in order to study upon myself the effects of ingestion into the stomach of the serous dejecta of cholera patients.

The opportunity presented itself last Saturday, the 8th, at the Hôtel-Dieu.

A young robust woman, taken with cholera at 4 a. m., was admitted 3 hours later under the service of M. Vulpien. When I became apprised of this fact it was 10.30, and M. Vulpien had just terminated his visit; but by the obligeance of the interne, M. Brunon, I easily obtained a quarter of a cubic centimeter of blood from the finger of the patient and some 30 cubic centimeters of the serous discharges, which contained a large proportion of the rice-like bodies. At this moment the visage of the patient presented a cadaveric pallor; the hands were cyanosed; there were cramps in the lower extremities; the serous alvine discharges escaped continuously.

The patient, after having been cold during the removal to the hospital, had become warm again in the bed. She concluded from this circumstance that she would not die, and even that she had no cholera, because her husband, carried off by the epidemic some days previous, had remained in the algid stage without experiencing the least thermic reaction. She therefore opposed a removal to another hospital, 'I shall become cold again,' she said, 'and die in the carriage.' She was kept at the Hôtel-Dieu, where, notwithstanding active and persevering treatment, she succumbed the day after at 7 p. m., after 39 hours of illness.

The blood was examined; it did not coagulate well, but the globules retained their normal characters. The serous alvine fluid contained a prodigious number of vibriones of every species, among which predominated very short bacteria whirling in the field of the microscope and moving in every direction with such rapidity that it was difficult to follow them with the eye. In the midst of this crowd of vibriones one could distinctly recognize, but not without difficulty, the comma-shaped bacilli.

The same Saturday I made, with 5 cubic centimeters of this fluid incorporated with the powder of lycopodium and gum, 5 large soft pills, which I successively swallowed at 3.30 p. m. I afterwards drank several times a large glass of ordinary water.

At 6 p. m. there was fever, with heat of the skin and 100 pulsations per minute (70 being normal). This fever persisted for 24 hours; at certain moments the pulse reached 120. At midnight some nausea; insomnia for three hours; dysuria during a part of this time, with

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\* *Cmpt. rend. de l'acad. de sci.*, 17 nov., 1884.



slight fibrillary convulsions in the muscles of the lower extremities, in the forehead, and in a finger of the right hand. Anorexia and constipation for 24 hours. I took an ordinary glass of alkaline purgative-water, and perfect health was re-established.

The fluid ingested had not, therefore, been entirely inoffensive, but it could not be said that the slight symptoms it provoked are those of cholera.

In animals the results have been more marked. A quarter of a cubic centimeter of the serous diarrhoeal fluid was injected under the skin of four guinea-pigs. Three of these pigs died, two during the night from Saturday to Sunday, the third during the night from Sunday to Monday. An adult dog received under the skin of the flank of each side a cubic centimeter of the same fluid; it had during the day of Sunday, some vomiting and purging; two days afterwards it returned to its normal condition.

The remainder of the fluid, kept in the laboratory, was again several times examined. Five days after it was obtained it contained a more considerable number of larger, mostly motionless bacteria; the comma bacilli appeared much more numerous, and were very easy to see at each microscopic examination.

This experiment proves that the ingestion into the stomach of the alvine fluid discharges of cholera, containing comma bacilli by no means necessarily produces an attack of cholera."

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#### *SOME EXPERIMENTS WITH CHOLERA DEJECTIONS ON THE LOWER ANIMALS.*

By VINCENT RICHARDS, F. R. C. S.\*

I.—On the 8th of February administered to a dog cholera fæces. Never affected.

II.—On the same day fed a dog with cholera dejections mixed with rice.

Passed perfectly natural stools; never affected.

III.—On the 11th of February gave a dog cholera dejections mixed with cold rice. Never affected.

IV.—On the 12th of February and five consecutive days a dog was fed on cholera dejections mixed with rice. Never affected.

V.—On the 17th and 18th of February a dog was fed with cholera dejections and rice. Never affected.

VI.—On the 17th and 18th of February, a dog was given cholera dejections. Never affected.

VII.—On the 23d of February fed a dog with cholera dejections; again on the 24th gave cholera dejections. Never affected.

VIII.—On the 24th of February fed a dog on cholera dejections. Never affected.

IX. On the same day fed a hog with cholera dejections. Never affected.

The discharges were invariably taken from the persons suffering the most seriously, and nearly all of whom died. The dogs were kept for several days under observation, and they never exhibited the slightest signs of having been in any way affected. It is within my knowledge that animals feed upon the bodies of persons dying from cholera, and apparently with impunity. If the cholera dejections contain a specific poison—whether in the shape of an organism or otherwise—it is clearly impossible to convey the disease in dogs in the manner in which the cholera-producing agent is generally supposed to find its way into the system, and to cause the disease in man. Should the bacilli be capable of setting up the disease, it is much to be regretted, in the interests of humanity, that they fail to do so in the lower animals, since it is manifestly impossible to put the matter to the test in the human subject. Again, it is to be regretted because experiments with a view to the discovery of a means of thoroughly disinfecting cholera dejections would have been considerably simplified. The fact of there being a cholera bacillus must, of course, be accepted in view of Dr. Koch's statements and demonstrations; but whether the bacillus itself gives rise to the disease, or whether it feeds

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\* From the Indian Medical Gazette, March, 1884.

upon or breeds in something which does, is a question which will not be easy to determine unless, indeed, Dr. Koch has succeeded in producing the disease by inoculating isolated bacilli. If the cholera bacilli are to be found in the cholera dejections, it is certainly not remarkable that the water which the people drink should also contain them, seeing that the clothes stained with cholera discharges are so frequently washed therein. To show that some of the people drinking such water suffer from the disease, may possibly amount to presumptive evidence that the water is the cause, but it by no means attains the dignity of scientific demonstration.

Nor do I believe that the eminent German *savant* now amongst us would claim that dignity for the discovery which he is said to have made. On the other hand, should it be shown that the bacilli or their nidus are never present in the cholera dejections, the fact of their presence in the drinking-water and within the bodies of the affected only, would amount to almost positive proof. I had determined, six or eight months since, to experiment with cholera dejections at the first opportunity, but merely with a view to test the means of disinfecting the discharges, and rendering them innocuous, but the investigation is brought to an end by the discovery that so far as I have been able to ascertain, the discharges are not capable of producing the disease, at any rate in dogs. It seems to be of the first importance to ascertain whether the bacilli of cholera are or are not invariably present in the milk of women suffering from the disease. I have shown in my paper on "Cholera amongst emigrants" (page 134, Indian Medical Gazette, May 2, 1881) that infants enjoy a most marked immunity from cholera. Of the 712 persons treated in Goalundo hospital, only 14, or 1.96 per cent., were infants. I know several instances of women who, while suckling their infants, were attacked with cholera and the infants remained unaffected. In the case of Mrs. R. (published in the Indian Medical Gazette), I saw her suckling her infant only a few minutes before she was violently attacked with cholera. The infant was never affected. This seems to indicate either that the bacilli are not present in the milk, or that they *per se* are incapable of setting up the disease.

MARCH 4, 1884.

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#### SOME NOTES ON THE POISON CONTAINED IN CHOLERAIC ALVINE DISCHARGES.

By VINCENT RICHARDS, F. R. C. S.\*

It has been customary—though not universally so—to regard the choleraic alvine discharges as possessing some peculiar poisonous properties. But so far as I am aware the fact has never been satisfactorily and conclusively established by actual experiments. Still less has any hint been given as to the true nature of the poisonous agent further than it was supposed to be a "germ" of some description. Dr. Koch, the eminent German *savant*, has discovered in choleraic discharges and within the bodies of the affected a peculiar bacillus which he believes to be the cholera-producing agent. He has not, however, succeeded in producing any appreciable results by the inoculation of isolated and cultivated bacilli. I have no knowledge of the details of Dr. Koch's investigations, but it is only natural to assume that had he met with any marked success in that direction we should have heard of it. In the March number of the Indian Medical Gazette I published a short account of some experiments made with choleraic dejections in the case of dogs, and it will be remembered that I failed to obtain positive results. By a lucky thought it struck me to try the experiment on pigs, which are, in this country at least, peculiarly foul-feeding animals. I gave to a small pig three months old a choleraic discharge which had just been evacuated by a patient in the hospital. The evacuation was of the pinkish color so common in the alvine discharges met with in the usual fatal form of the disease. This was in the morning when I visited the hospital. In the evening it was reported that the animal had vomited once after being very restless, and that it had soon afterwards died. At the post-mortem examination I found the stomach contained a glairy yellowish fluid, part of the smaller intestines empty, and the rectum full of semi-fluid grayish fæces. The lungs were much congested, the right side of the heart was full of fluid blood,

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\* From the Indian Medical Gazette, April, 1884.



and the left empty. The blood was fluid. It was fortunate that in this instance the alvine discharge contained the poison, or, in view of my past experience, I might have been inclined to abandon the inquiry. It is well known that country pigs consume human excrement, which must be to them under ordinary circumstances perfectly innocuous. But the following experiments show that they can consume even suspected discharges with apparent impunity.

I. Removed the semi-solid contents of the intestines of a pig which had been killed by the alvine discharges of the cholera patient, and after liquefying them with water administered the whole to a half-grown pig. Never affected. The next day gave it the alvine discharges from a patient who was apparently suffering from the first stage of cholera. The discharge though rice-water like, was slightly colored with bile. The patient, I might say, recovered. The animal was never affected, but it was on a subsequent occasion some days afterward killed in 1 hour and 28 minutes by the administration of an undoubted choleraic evacuation.

II. Removed the contents of the intestines of a patient who died over night from cholera and gave half, about 2 ounces, to a half-grown pig. The fluid had a most offensive odor and was partly decomposed. Kept several days under observation, but was never affected. The same experiment was repeated on the animal, but it remained unaffected.

III. Administered the other half of the fluid referred to in experiment II to a half-grown pig. Kept many days under observation, but was never affected. Repeated the experiment with a suspected evacuation, and, although it appeared to be unwell, it was never seriously affected. This animal had a spear wound in the side, and it became rather weak. On a subsequent occasion it died *in fifteen minutes* after having him given the contents of the intestines of a patient who had died 2 hours previously from cholera.

In strong contrasts to these experiments are the following, which prove the extreme malignity of the poison contained in choleraic alvine discharges at certain stages of the disease. I may here observe that the pinkish colored evacuations appeared to be the most poisonous.

IV. On the 18th of March, at 10.30 a. m., I removed the fluid contents of the intestines of a patient who had died from cholera, and administered them to a nearly full-grown pig. The fluid resembled an ordinary cholera evacuation of a pinkish color.

At 11.20 the animal passed a large quantity of semi-fluid clay-colored fæces. It became very restless and gasping for breath.

1 p. m.—Passed another stool of a similar character. Still more restless, and the respiration is much embarrassed; soon after this it became convulsed.

1.10 p. m.—It again passed similar fæces.

1.20 p. m.—Dead—in 2 hours and 50 minutes.

V. At 9 a. m. gave a cholera evacuation to a half-grown pig. At 9.15 a. m. it became extremely restless and the respiration greatly embarrassed. The nose and ears, which had been of a light pink color, became bluish. The animal's restlessness increased and at intervals there was an ineffectual attempt to take a long inspiration.

9.58 a. m.—Strongly convulsed.

10 a. m.—Respiration ceased, but it was not until 10.28 a. m. that the heart's action ceased. The chest was opened some time after the cessation of respiration. The animal had passed a small quantity of urine, which was found to contain albumen and a trace of uroxanthine. I should have tested for the chlorides, as suggested by Crombie, but had no nitrate of silver at hand. It is not important, however, as in such an acute case and in the absence of any purging, it is scarcely likely that there would have been any marked deficiency of the chlorides.

The principal post-mortem appearances were the following: The lungs were normal, the heart very nearly empty. The rectum contained a small quantity of solid fæces. The small intestine contained a small quantity of bloody fluid and the large intestines were empty. The stomach contained a small quantity of greenish-colored fluid. Liver gorged with blood; gall-bladder full. Kidneys also gorged with blood. Blood fluid throughout.

In the face of these results it can no longer be questioned that the alvine discharges at certain stages of cholera do contain a powerful poison, whose chief action is to enfeeble and destroy the function of respiration. And in this respect it seems *somewhat* to resemble the

action of the proteid—venom globulin—which has been discovered in the venom of snakes by Drs. Weir Mitchell and Reichert. Now, what is the nature of the poison? Is it an organism or is it a chemical compound? In my opinion the rapidity with which it acts altogether excludes it from the possibility of its being an organism. While, on the other hand, the rapidity of its action and its comparative instability as plainly indicate that it is in the nature of a chemical compound, possibly, but this is a mere conjecture, an albuminoid body. Its instability is, I think, very clearly shown by experiments II and III. The poison which had, no doubt existed in the fluid of the intestines had been destroyed by decomposition; at least that appears to be the most probable explanation of the innocuousness of the material used in those two experiments. Had the poisonous character of the alvine discharges depended upon the contained bacilli, the results of the experiments would have been different, since the decomposition of the vehicle would scarcely have affected the vitality of the bacilli. I would not be understood to mean that I think it impossible the poisonous element is given off during the decomposition of the evacuations. I do not emphatically believe that the evacuations lose their toxic qualities by decomposition; but whether the poison is given off or is destroyed, it is at present impossible to say, though the probabilities are much in favor of the latter supposition. It may, of course, be questioned whether the poison now proved to exist in choleraic alvine discharges is the identical poison which produces the disease. But I would point out that the principal physiological effect is precisely the same. Any one experienced in the observation of cholera cases knows that the really prominent symptoms are the restlessness and distress consequent upon embarrassed respiration. In this connection Dr. Aitken remarks: "The post-mortem appearances and the order of the symptoms tend to show that the blood is obstructed in its passage through the lungs, and the loss of the animal heat, embarrassment of the respiration, and the gradual arrest of circulation are produced by some aberration of the proper respiratory changes or impediments to them." The purging, which is not a prominent symptom in the pigs experimented on, may be *mainly* due to paralysis of the mesenteric nerves, the result of the circulation of a vitiated or imperfectly oxygenated blood, or it may be a mere effort of elimination. The poisoning of the pigs was so rapid that there was not sufficient time for the complete evacuation of the intestinal canal, though it will be noted that a bloody fluid was found in the intestines of one of the animals. There are of course other explanations, either there may be some slight difference in the mode of action of the poison in the case of pigs and that of man, or exterior to the system it may acquire a further special property. Be this as it may, the main physiological character of the two poisons is precisely the same. What is now required is a most thorough and searching inquiry into the chemistry of the alvine discharges in cholera, so that the poison may be, if possible, isolated and its chemical and physiological characters definitely determined. As regards disinfection, I am persuaded that from the nature of the poison the best means of disinfecting choleraic evacuations is the admixture of a solution of the permanganate of potash; but I have not yet had an opportunity of deciding the question. I would thus summarize the results which I think fairly deducible from my investigation.

(1) That choleraic evacuations at certain stages of the disease contain a most virulent poison.

(2) That if the poison finds its way into the stomach it is absorbed and rapidly proves fatal.

(3) That the principal action of the poison is to enfeeble and destroy the function of respiration.

(4) That the poison is not an organism, but of the nature of a chemical compound of a comparatively unstable nature.

(5) That it will probably be found to be easy to destroy the power of the poison existing in the evacuations; in other words, to disinfect them.

(6) That, although the poison decomposes, it might by desiccation retain its powers for some considerable time. Hence, clothes, etc., stained with choleraic discharges might be a source of danger.



## ASIATIC CHOLERA IN THE PIG.

BY J. C. LUVAS.\*

Apropos of the intelligence wired a week or ten days ago by the Calcutta correspondent of the Times that Mr. Vincent Richards had succeeded in inoculating the pig with the specific virus of cholera, and adding that, in his opinion, it is of a chemical nature, and of the fuller details to hand by the last mail, as published by your contemporary, the Indian Medical Gazette, I think it as well to recall attention to the report of an epidemic of cholera in cats at Ahmednuggur and Sirror, published early this year by the Government of Bombay, and which I noticed briefly whilst in India in these columns. That report is of peculiar interest so far as the causation of cholera in the cat went, inasmuch as at the time when this epidemic in the cat was at its height an epidemic of cholera was prevailing (in the human subject) at those places, and from what I could gather from a careful perusal of the report in question it appeared that the feline epidemic took its origin from that in the human subject or from a common *fons et origio*, whatever that may have been. I would also invite special attention at the present juncture to a very interesting report on an epidemic of cholera in cats at Delhi in, I think, the year 1875, and published in the Lancet of 1876 by Dr. Fairweather, of Her Majesty's Indian medical service, at that time civil surgeon of that place. Since that report was published I have several times experimented with cholera evacuations to see if I could produce cholera in dogs, cats, and rats, but with negative results.

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Against the views that are now being advanced by Mr. Richards there is, however, this to be said, that in India it is a notorious fact that village pigs feed on human excreta. At some time or another these are choleraic, but the occurrence of the disease in the pig has never been heard of.

I trust that I will not be understood to suggest that the researches of this gentleman, to whom medical science is not a little indebted for his valuable researches in connection with snake (cobra) poison, are open to question, though seeming to be plausible; but that the subject is of such paramount moment and vital concern that we can not but scrutinize most cautiously every step and link in the chain of evidence which comes before us. We may therefore welcome what is now before us from the pen of Mr. Richards, and hope that he will continue his researches and observations, and, to use the words of Dr. Wilkes, "We take the world as we find it and endeavor to unravel its mysteries; but the Alpha and Omega we know not."

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ON THE PRESENCE OF BILIARY SALTS IN THE BLOOD OF CHOLERA PATIENTS AND ON THE  
EXISTENCE OF A TOXIC ALKALOID IN THE DEJECTIONS.

BY G. POUCHET.†

1. In a recent communication, MM. Nicati and Rietsch expressed the opinion that cholera might be regarded as an enteritis complicated by a retention of bile, and they called attention to chemical researches conducted with the object of elucidating this point in pathology. During the last ten days I have been conducting at the laboratory of the St. Louis Hospital a series of researches, of which I shall at present give only the principal results.

I have examined the blood of the heart and of the large vessels of four cholera patients who died in the algid period, and I have been able to discover each time the presence of a notable quantity of biliary salts. The most minute precautions were always taken to avoid the mingling of the blood with any other fluid. The reaction of this blood has always been neutral or slightly alkaline.

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\* A letter from J. C. Luvass to the editor of the Lancet, May 24, 1884.

† Compt. rend. de l'acad. de sci., 17 nov., 1884.

Another observation which has just given still more importance to this first result is the following: One knows that suppression of the urine is complete or nearly so during the period above mentioned. Now, on collecting the urine of patients who have reached the period of reaction I have demonstrated in it the presence of a notable quantity of biliary salts.

The bile undergoes in its chemical composition very interesting alterations, which may explain to a certain extent the rarity of icterus in cholera patients. I have, in fact, observed in the four cases in which I have examined the blood that the gall-bladder was engorged with a semi-fluid material of a consistence almost gelatinous, grayish or slightly tinted green, and containing a considerable proportion of albuminoid substance.

What becomes of the normal coloring of the bile? Whence come the biliary salts existing in the blood? Are they formed in the liver and absorbed by the blood, or must their presence be attributed to a failure of secretion by the liver? I am not yet in a position to answer these questions, for their solution necessitates long and delicate researches. A fact absolutely certain is this: There exists in the blood of persons who have died during the algid period of cholera a quantity of biliary salts, at times considerable.

The cholera dejecta possess almost always a strong alkaline reaction.

2. Treated by means of chloroform the dejecta yield to this solvent an oily, fluid substance, easily oxidizable, and endowed with an extremely toxic power. This compound is certainly a ptomaine, of which I am now continuing the examination. Subcutaneous injection of a trace of this fluid practiced upon the frog kills it rapidly, with a considerable slowing of the movements of the heart, and after death the most intense rigidity is observed.

W. Nicati has also found the biliary salts in the blood of cholera. (*Choléra et cholémie*. Note de M. Nicati, *Ibid.*, 24 nov., 1884.)

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#### ODOR AND TOXIC EFFECTS OF THE PRODUCTS OF THE FERMENTATION PRODUCED BY THE COMMA BACILLI.

NOTE BY NICATI AND RIETSCH.\*

Pure cultures of the comma bacillus present a characteristic odor which is not at all putrid or disagreeable, but, on the contrary, is something etherial; the odor is that of the intestinal contents at the commencement of cholera, especially if the latter be exposed for 24 hours in the moist chamber to a temperature of 25° to 35° C.

If, by means of the Pasteur filter, the bacteria are removed from pure cultures *eight days old at least*, either in bouillon or nutritive gelatine (formula of Koch), and the filtered fluid thus obtained is injected into the circulation (jugular vein, crural vein) of dogs, the following symptoms are observed:

In a first series of experiments, vomiting, purging, general depression, followed by recovery in an hour.

In a second series, we observed disturbances in respiration, characterized by more profound inspirations and expirations, disturbances of the digestive organs in the form of repeated efforts at vomiting. Remarkable motor disturbances are also manifested. A dog, which ultimately recovered, could not stand upon its feet; when supported it made futile efforts to walk, the fore paws were flexed as a result of the motor paralysis produced by the injection. A smaller dog fell down motionless, keeping its eyes open, however, and exhibiting very slight movements of the tail when it was caressed, which seemed to indicate that its intelligence and sensibility were retained. This dog died during the night, after more than 12 hours. There was rapid elevation of the temperature. At the autopsy we found extensive ecchymotic spots in the duodenum and some smaller ones in the stomach; the urinary bladder was empty, the cortex of the kidneys was greatly injected; the blood of the heart and large vessels, of a dark color, was entirely free from clots, and it presented the characteristic signs of solution of the

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\* Cmpt. rend. de l'acad de sci., 24 nov., 1884.



hæmoglobine, which one of us had previously pointed out as belonging to the algid stage of cholera.

The same filtered fluid injected under the skin of various animals, even in greater quantity, produced no effect.

Recent cultures filtered in the same way and injected under the skin or into the circulation were found to be absolutely inactive.

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#### ATTENUATION OF THE CHOLERA VIRUS AND ACQUIRED IMMUNITY.

NICATI AND RIETSCH (Attenuation of the cholera virus. *Compt. rend.*, July 13, 1885), found that although comma bacillus cultures when fresh produced fatal results with the symptoms of cholera if injected into the intestinal canal of guinea-pigs, yet after the lapse of six or seven months they were found to have lost their pathogenic power, but subcutaneous injection was in that case followed by no result even when fresh and virulent cholera bacillus cultures were administered.

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#### UPON THE FORMATION OF PTOMAINES IN CHOLERA.

By A. VILLIERS.\*

1. Since the first discovery of the toxic alkaloids which are formed in putrefying cadavers the question has often arisen if analogous alkaloids are not to be found during life in certain diseases which end by a genuine poisoning.

I undertook, in November last, to search for the existence of alkaloids in the organs of two cholera corpses, which M. Heyem had placed at my disposal. (These two cholera patients, both 63 years of age, died at the St. Antoine Hospital, the first after 5 days of illness, the second the same day of his admission to the hospital, after having exhibited characteristic symptoms, the first without having undergone any other treatment than revulsives applied to the skin, the second without having had any treatment whatever.) Their organs, examined 24 hours after death for the first, 12 hours after death for the second, gave me identical results.

I extracted, by the method of Stas, an alkaloid which was distinctly characterized by its alkaline reaction and its behavior with chemical reagents. I found it in considerable quantity in the intestines (an amount represented by at least 0.02 of a gram of the pure crystalline hydrochlorate). The kidneys contained very decided traces of it; the liver and the blood of the heart scarcely any.

2. This alkaloid is liquid; it possesses an acrid taste and quite a free odor of hawthorn (aubépine).

With litmus its reaction is alkaline; it is a strong base, which is not liberated by the alkaline bicarbonates, but only by the alkalies. Its solutions and those of its salts give a white precipitate with the iodide of mercury and potassium. The iodated iodide of potassium gives a brown precipitate, even in extremely diluted solutions where the iodide of mercury and potassium no longer precipitate, contrary to what is usually the case with alkaloids. Bromine water gives a yellow precipitate. Picric acid yields a yellow precipitate. Tannin and the bichloride of mercury cause a white precipitate from concentrated solutions. The chloride of platinum and the bichromate of potash do not produce a precipitate. The ferricyanide and the perchloride of iron added to the solution of the alkaloid or of its salts do not immediately show the reactions of ptomaines, and this reaction subsequently develops only very slowly.

Pure sulphuric acid poured upon the alkaloid produces a slight and fugitive violet color.

The hydrochlorate of this alkaloid is neutral to litmus; it crystallizes in long, fine, transparent needles, extremely deliquescent.

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\* Presented by M. Barthelot, and sent to the Committee on the Bréant legacy. *Compt. rend. de l'académie de sci.*, 1885.

3. I have studied the physiological action of this alkaloid, in aqueous solution. The small quantities at my disposal did not permit me to make a large number of experiments.

Small doses (1 to 2 milligrams) injected under skin of a frog did not produce any well characterized effect. The number of heart beats of the frog was a little lessened at first, from 39 to 34, but it again returned to 40. Upon another frog I observed, twenty minutes after the injection the production of muscular movements, which quickly ceased and were not well marked.

I injected under the skin of the thigh of a young guinea-pig the remainder of the alkaloid, a quantity representing about 6 milligrams of the hydrochlorate dissolved in a half cubic centimeter of water. The physiological effects this time were very marked. They consisted at first in periodical variations of the number of heart beats. They were per minute as follows:

Before the injection . . . . .	2.58	Five minutes after . . . . .	2.64	Five minutes after . . . . .	2.22
Five minutes after . . . . .	1.49	Do. . . . .	9.90	Do. . . . .	2.70
Do. . . . .	2.58	Do. . . . .	2.52	Do. . . . .	2.22
Do. . . . .	1.50	Do. . . . .	1.20	Do. . . . .	2.28
Do. . . . .	.60	Do. . . . .	2.94	Two days after. . . . .	2.46

Three-quarters of an hour after the injection the anterior extremities were violently agitated by a rapid trembling, which afterwards invaded the posterior members and quickly vanished. Following this the animal refused to eat, and death supervened only four days after the injection. At the autopsy I found subpleural ecchymoses; the heart, arrested in diastole, was full of blood; the brain was a little congested.

As one sees, the most striking result was the periodic variation observed at first in the number of heart beats, which sensibly varied in the proportion of 1 to 5, and in the violent nervous trembling produced three-quarters of an hour after the injection.

4. Thus, as I have stated, an alkaloid is found, especially in the intestine. But its presence in small quantity in the kidneys and its almost complete absence from the blood and from the liver seem to indicate a rapid elimination by the urine.

I propose to investigate whether or not alkaloids are formed during life in the organs of certain other diseases, especially in typhoid fever. The study of these alkaloids might perhaps afford useful therapeutic indications. Possibly, if it be true that these diseases terminate by a poisoning, one might be able to prevent the latter from taking place by means of an antidote administered continuously until the cause of the production of the poison may have disappeared.\*

The study of these alkaloids may besides have great interest for toxicology. Their formation shows once more that it does not suffice to find a toxic substance in the organs in order to be able to affirm a case of poisoning, and that it is absolutely indispensable to define the nature of this substance.

The same author (*Ibid*, p. 1078) has by means of the same method extracted an alkaloid from the organs of two children dead of broncho pneumonia following rugeola (no alkaloid had been administered during the disease). This alkaloid presents very sensible differences from that which he extracted from the organs of cholera patients. It differs from the latter by its odor, its taste, its feeble alkalinity, the properties of its hydrochlorate, and some of its reactions; its physiological properties and its mode of localization are also different.

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\* Perhaps in cholera one might try the continuous action of iodine water in such a manner as to continuously transform the alkaloid into an insoluble combination; or, if this produce a caustic effect upon the mucous membrane of the intestine, especially upon that which has lost its epithelium, one might perhaps try the action of iodide of starch.



## CONCERNING THE POISONOUS NATURE OF THE COMMA BACILLUS.

By PROFESSOR CANTANI, of Naples.\*

Believing that the thickening of the blood in cholera is not sufficient to explain the symptomatology of the disease, and that we must believe in the action of a specific poison, Cantani undertook to find out whether the poisonous effect was due to ptomaines—poisons secreted by the bacilli—or to the poisonous effect of the bacilli themselves. His experiments supported the latter view.

Pure cultures of cholera bacilli in flesh-peptone-bouillon, which were sterilized by heating to 100°C, injected into the peritoneum of dogs produced the symptoms of a cholera poisoning, whilst the simple sterile flesh-peptone-bouillon used in the same way excited no symptoms at all; and, besides, the injection of flesh-peptone-bouillon containing living bacilli was not always followed by choleroïd phenomena. "From this it would seem that the dead cholera bacilli, when absorbed, poison the body very much like poisonous mushrooms do when eaten."

But since the cholera poison is always produced, we are forced to admit that the more numerous the cholera bacilli, the more the poison is generated and reaches the blood.

The therapeutic indications would therefore be:

- (1) Limit the development of the cholera bacilli in the intestinal canal:
- (2) Assist elimination of the absorbed poison.

The so-called *tannic enteroclysis* meets the first indication better than other means heretofore put into practice, all the more as experiments concerning the action of tannic acid upon cultures of cholera bacilli at 37°C. show that one-half to 1 per cent. of tannic acid succeeds in impeding development of the bacilli and in making the already advanced cultures sterile for transplanting to other media.

The second indication is met by *hypodermoclysis*, which, even if it may not be indicated by the danger which threatens through thickening of the blood, yet reduces by one-half the mortality of grave cholera attacks. Furthermore, the tannic enteroclysis is useful in causing the resumption of urination, and thus meets the second indication, while thereby also augmenting to a considerable degree the effect of the hypodermoclysis.

## A CHOLERA PTOMAINE.

Klebs (Correspondenz-blatt f. Schweizer Aerzte, 1885, No. 13), who, with Koch, believes that the severe symptoms of cholera in the human being are due to a chemical poison which the cholera bacteria produce, failed to find the artificial production of these symptoms in guinea pigs. The author sought to learn if Koch's comma bacilli produce such a poison in nutrient gelatine. To this end the author added to 2 or 3 kilograms of sterilized beef broth some cholera bacilli, and allowed the whole to grow at a temperature of 35° C.; he then acidulated the broth with hydrochloric acid, filtered, and added to the filtrate chloride of mercury in excess. The precipitate formed was filtered, suspended in water and freed from the mercury by treatment with sulphuric acid; the precipitate was moistened, then dissolved in a little water and neutralized by caustic soda. Two cubic centimeters of this fluid was injected into the jugular vein of a rabbit, with the production of marked nervous phenomena, narrowing of the pupil, dyspnoea, twitching of the muscles, followed by severe cramps. In the second animal, 3 minutes after a similar injection, cramps, widening of the pupils, and, 3 minutes later, death followed. The heart was arrested in diastole, but, under the influence of air, again began to beat. A substance obtained with the double salt of platinum in another manner from a cholera-culture was very similar in its action, although less energetic. Klebs considers these experiments to warrant the assumption of the existence of a cholera poison, and thinks that this poison probably belongs to a large group of substances produced during the growth of bacteria.

\* Tageblatte der 59. Versammlung deutscher Naturforscher und Aerzte zu Berlin, 1886; from "Baumgartner's Jahresbericht, zweite Jahrgang, 1886, and Giftigkeit der Cholera-Bacillen (Deut. med. Wochenschrift, 1886, No. 45.

## THE ETIOLOGY OF ASIATIC CHOLERA.\*

Dr. Hueppe concludes, from his studies and from those of Wood, of Edinburgh, upon the nature of cholera, that it is a process limited to the intestine; it is biologically a specific intestinal putrefaction with the production of a specific toxin. The loss of water and the denudation of the intestinal mucous membrane of its epithelium, though important symptomatically, are without etiological relation to the disease. As far as experiments yet indicate, the cholera bacteria, whether entering the system in a moist or dry condition, and whether inhaled or swallowed, always reach the intestine by way of the stomach. It has been found that with a proper selection of nourishment, but without the presence of oxygen, the cholera bacteria produce their poison more energetically and more quickly than under the ordinary conditions of culture in the presence of air. This is in accord with the fact that the cholera process is carried on in man under the conditions of anaërobiosis. Wood has shown conclusively that bacteria in a state of anaërobiosis are much more sensitive to external conditions than when in a condition of aërobiosis. The cholera bacteria, therefore, though very energetically producing toxin in the intestine, are much more sensitive to external agents, so that traces of acid are sufficient for their destruction. They are more easily destroyed in the fresh stool than at any other time. From a clinical stand-point, therefore, it is important to disinfect the stools and the linen at once, since with delay the resistance of the micro-organisms increases. A therapeutic indication depending on the facts brought forward is to administer by the mouth some substance which may pass the stomach unchanged, and in the intestine act upon the bacteria. For this purpose salol appears to be best fitted, in the effort to exert an internal and perhaps specific action against the disease. These observations account for the hitherto puzzling fact that cholera only seldom is contagious, transmitted directly from the sick to the well. The bacteria are in such a susceptible condition on leaving the bowel, that even if they at once find their way into the stomach of a healthy person, they will almost certainly be destroyed by the gastric juice. In a short time, however, the anaërobic cholera bacteria outside the body, in the presence of air and supplied with proper nourishment, become aërobic. It is also true that the cholera bacteria in the anaërobic condition are much more particular in the choice of their nourishment than when aërobic; and this constitutes another ground for their increased power of resistance outside of the body. The author also maintains that there is a third form—the arthrospores—which is even more resistant than the vegetative aërobic form. In any case, should any of the forms whose power of resistance has been increased enter the stomach, it would seem that they are not destroyed there, even by the presence of acid, but pass into the intestine, and there complete the *circulus vitiosus*. Pettenkofer has, with reason, made prominent the epidemiological observation that, as a rule, the cholera infection is indirect, being influenced by external conditions, the principal of these conditions being the variations in the ground-water. With the diminution of the ground-water—*i. e.*, with the diminution in the degree of dampness in the upper layers of the ground, the danger of cholera increases; while with the increase of dampness in the upper layers the danger decreases. The proper explanation of this would appear to be that the cholera germ enters the ground in its most sensitive and least resistant condition. If too much moisture—*i. e.*, too little air and atmospheric oxygen—is present, they simply perish. If the ground is only damp, so that air can reach them, as aërobic they increase at the expense of the nutrient matter present. If now, with these viable cholera germs in the ground, the ground-water diminishes, the conditions are those most favorable to aërobic life, and the cholera germs increase. The preliminary conditions are thus fulfilled for a miasmatic spread of a cholera epidemic. If, on the other hand, while an epidemic is in progress the ground-water increases in amount, the bacteria can no longer increase, and are either destroyed or rendered inactive, and the epidemic ceases for want of suitable infectious material. Of course, these bacteriological facts are not the only epidemiological factors; but the conclusion seems justifiable that Asiatic cholera is truly a miasmatic-contagious disease, with epidemiologically marked prominence of the dependence upon external circumstances, the nature of which bacteriologically has now become clearer.

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\* From the Med. Rec., Sept. 13, 1890, and Amer. Jour. of Med. Sci., July, 1890.



CHEMICAL INVESTIGATIONS CONCERNING THE SUBSTANCES WHICH ARE ELABORATED IN THE FERRÁN BOUILLON IN THE LIQUID CULTURES OF THE COMMA BACILLUS.

BY VIVEZ, PELEGI AND MUNTA.\*

Is the comma bacillus or the peronospora Ferrani the cause of the disease? Is it certain that the bacillus is found in the digestive apparatus of healthy man? Is it the cause or the effect of cholera? If the bacillus is not directly the thing which produces the disease, can the latter be due to some chemical product elaborated by it?

Neither is it incumbent upon us, nor this the occasion, to respond to the first questions. With respect to the last, the subjoined analytical studies, which we have brought to an end may perhaps serve for a reply.

Before entering at length into this question we would make some remarks concerning the object of our study and the circumstances which have prompted it.

The symptomatology of the disease, the fact observed by some that cholera can be produced by injections of pure cultures without encountering the bacillus in the blood or in the digestive apparatus, as also the affirmation that the same results have been obtained by injection of cultures which have been subjected to the action of heat, have given ground for supposing that the micro-organism may not be the direct, but the indirect, cause of the disease, through the action of a product of a chemical nature elaborated by the microbe. That is to say, the theory has been advanced similar to that which has been set up in the case of the micoderma vini, where alcohol, carbolic acid, and other products of alcoholic fermentation are formed.

This being a problem of such interest and transcendental importance the board of military hygiene could not remain indifferent to its solution, and therefore, your excellency, who have always distinguished yourself by your active patronage of the sciences, and who with so much earnestness has desired that the military board of hygiene should occupy a prominent position in the progressive movement of human knowledge, determined to nominate a commission, charged with making a careful investigation of attenuated cultures of the comma bacillus, such as those used for inoculation, and having for its principal object the isolation of the products elaborated in the culture fluids.

*Analysis.*—The first analyses were performed upon some specimens of broth prepared by Dr. Ferrán. In these, following the procedure which is detailed further on, the presence of a ptomaine, perfectly characterized by means of its reactions, was demonstrated. These reactions will be found related at length at the end of this report, and for this reason we will not repeat them here.

The Commission deemed it advisable that the analysis should be made upon a large scale, because although more dangerous, isolation of the ptomaine and the determination of its character and reactions would be more easy. To this end your excellency ordered that large quantities of cultures be furnished by the chemical laboratory of the military hospital.

Having received 18 kilograms of the culture of the comma bacillus we proceeded at once to its microscopic examination, which latter proved that the broth contained small numbers of the comma bacillus, probably because of the fact that it (the broth) was only recently inoculated. On this account we thought it advisable to keep the cultures in the incubating oven for the space of 8 days at a temperature which oscillated between 30° and 35° C. This period having transpired, a new microscopic examination showed that the number of microbes had very considerably increased. The chemical investigation of the broth was now proceeded with.

The broth presented the following characteristics: Amber color, cloudy, of an odor and taste *sui generis*, uniform throughout its whole mass, and of an alkaline reaction. It was distilled in an appropriate apparatus in which all of the volatile products could be collected. The vapor bath being employed without the temperature rising above 45°, in order to prevent as much as possible the alterations of the principles contained in the broth, as also of those which

\* Report to His Excellency, the Military Director of Health, Madrid, March 17, 1886.

might have evolved in the development in the microbes, the distilled liquid was collected in several portions, in order to separate as much as possible the more stable from the less stable, the more fixed from the more volatile, and it was tested by the proper re-agents for alkaloids and ptomaines, with the result that it did not appear to contain any principle of this nature which could be passed over in the distillation.

The re-agents employed were: Red litmus paper, blue litmus paper, turmeric paper; solution of nitrate of silver, 10 per cent.; solution of chloride of mercury, 10 per cent.; solution of chloride of platina, 10 per cent.; solution of chloride of gold, 10 per cent.; solution of ferricyanide of potassium, 10 per cent.; solution of tannic acid, 10 per cent.; solution of bichromate of potassa, 10 per cent.; re-agent of Erdmann, re-agent of Mayer, re-agent of Pentel, re-agent of Froehde, re-agent of Marmé.

The absence of principles in the distilled liquid being demonstrated, examination proceeded with the residuum of the distillation. This was a substance, sirupy, yellowish in color, of an odor like glue, and of a repugnant taste. It was mixed in the closed apparatus with triple the volume of pure absolute ethylic alcohol and agitated a short time, a few drops of alcoholic solution of sulphuric acid were added in order to neutralize the alkalinity of the broth. The liquid was again tested at the end of 48 hours, and if its degree of acidity were very slight a few more drops of acid were added. If on the following day the same degree of acidity was found to be maintained, we proceeded to the separation of the alcoholic liquid from the aqueous residue which filled the bottom of the flask.

The said residue, which appeared heterogeneous, composed of two layers—an inferior, granular and whitish, and a superior, yellowish and viscid—was subjected to the former treatment in order to remove the slightest trace of the acid salt.

*Acid alcoholic liquid.*—The united alcoholic liquids were distilled. In order to avoid alteration of the principles by the action of the air, and facilitate the distillation at a low temperature, distillation was performed *in vacuo* by means of the following apparatus: The alcoholic liquids were placed in a three-mouthed bottle, submerged in a marine bath. One of the mouths was furnished with a long glass curved tube placed in communication with mercury, serving in fact as a manometer; another was furnished with a thermometer; and finally the last was placed in communication by means of a wide glass tube with a reservoir containing water; the latter was connected with two Liebig tubes, the proximal end of which contained a solution of chlorohydric acid of 10 per cent., and the distal contained distilled water and communicated with a retort of Gay-Lussac.

Neither in the distilled alcohol nor in the liquid of the Liebig tubes was there the slightest indication of any substance contained.

The residue of the distillation, completely freed of alcohol, was submitted to the action of ethylic ether twice consecutively. Evaporation of the etheric liquid to dryness left a residue slightly acid, partly soluble and partly insoluble, accompanied by fatty matter and coloring matter, but in it no indications, by means of the reactions above enumerated, of alkaloid substances were met with.

The residuum insoluble in ether after the former treatment was rendered alkaline with the nitrate of barium and a new quantity of ethylic ether was added with the object of dissolving the alkaloids, ptomaines and substances behaving like them.

This operation was repeated twice and the etheric liquids being added together were filtered and distilled at a temperature of 25° to 28° C. in *vacuo*, and with the precautions essential to such a delicate operation.

The rigorous exactness of the method employed insured our arrival at the point of isolation of the ptomaines in case there were any.

The residuum of the distillation is a ptomaine perfectly characterized by its properties and reactions, being precisely the same as that met with in the bouillon of Ferrán.

*Characters of the ptomaine.*—It is solid, of a buttery consistence and yellowish color, becomes dry by the action of the air, is of a heavy and nauseous odor and of a bitter taste,



uncrystallizable, soluble in water, alcohol, ether, chloroform, and in the dilute acetic, nitric, and chlorohydric acids is strongly alkaline by litmus and turmeric paper.

The ptomaine and its chlorohydrate and acetate salts, which are less changeable, give the following reactions:

Re-agent of Mayer .....	{ An abundant flocculent yellowish-white precipitate, which does not become crystalline in 24 hours.
Re-agent of Schwarzenbach.	No precipitate or change of color in 24 hours.
Re-agent of Sonnenschein.	Amorphous, yellowish precipitate rose-color liquid in 24 hours.
Re-agent of Marmé.....	Amorphous, rosy-yellowish precipitate.
Potassic cyanide of silver {	Amorphous, grayish white precipitate; does not appear until after 24 hours.
Chloride of platinum .... {	Canary yellow, crystalline precipitate, which is slow to appear; examined under the microscope it is formed of very confused laminated crystals.
Chloride of mercury .....	Immediate precipitate of amorphous, white flocculi.
Bichromide of potassium (10 per cent. solution.) {	After some time a pulverulent sediment is formed, which, seen under the microscope, appears to consist of groups of slightly yellow prisms united in the form of rosettes.
Solid bichromate of potassa and sulphuric acid. {	Rapid reduction; the appearance of a gray color, which passes to a dirty green, and finally emerald green.
Tannic acid.....	An amorphous, gray precipitate which forms slowly.
Ferri-cyanide of potassium and chloride of iron.	Reduction with formation of a blue precipitate.
Iodic acid .....	There is no reduction.
Dilute sulphuric acid.....	Solution.
Concentrated sulphuric acid.	{ De-organization with swelling, and a color of cinnamon of a violaceous aspect.
Nitric acid .....	Solution, with slight yellowish color.
Re-agent of Froehde.....	Red flesh color, which persists some hours.
Iodine in iodide of potassium.	{ Amorphous gray precipitate.
Re-agent of Mayer.....	Crystalline, yellowish precipitate.
Re-agent of Dragendorff...	Amorphous, whitish precipitate.

The chlorohydrate of the ptomaine crystallizes in acicular prisms.

On account of these re-actions the Commission think that they may characterize the product isolated as an alkaloid of the class of ptomaines.

*Physiological tests.*—The presence of a ptomaine being already demonstrated in the cultures, we proceeded to test its action upon the economy.

Two series of tests were devised: In the first, the ptomaine was administered by ingestion; in the second by injection.

Ingestion by a man of the pure ptomaine in the quantity of 5 milligrammes, aside from the disagreeable and nauseating taste which characterizes it, occasioned no trouble or disturbance of function. The experiment was performed upon one of the members of the Commission.

Double this proportion was injected into a guinea-pig without producing any notable phenomena.

The experiments by hypodermic injection were performed upon guinea-pigs. Into each one a cubic centimeter of distilled water which held in solution of a centigramme of the pure ptomaine was injected with a syringe of Pravaz. The injection was performed in the epigastric region with the result of producing a painful phlegmon at the point of puncture and a general state of excitement, accompanied by increase in the number of inspirations, rise of temperature, and some evacuations, not, however, of a diarrhœic character. After a half hour they became exceedingly prostrated, approaching a moribund condition, without appetite, but in 24 hours recovered their habitual vivacity, and to-day they are perfectly well.

In other guinea-pigs the injections were performed with the chlorohydrate of the ptomaine, followed by identical phenomena although more pronounced.

From all of which the Commission deduce: That the comma bacillus develops in its cultures a principle of the nature of a ptomaine, different from the ptomaines already discovered; that this ptomaine is stable and can form crystalline salts; that although it produces in guinea-pigs a pathological disturbance, it does not possess the intensity which has been supposed; per-

haps upon man the action may be more energetic, since the intensity of the poison is very different according to the species of animal upon which it is tried, but the Commission have had no means of reaching that point of experimentation.

In the manner above described it has been demonstrated that in the liquids in which the comma bacillus lives a principle, of basic reaction, of the nature of the alkaloid, is developed, *i. e.* produced in the animal organism, and this principle receives the name of a ptomaine. This new principle presents, in a manner which leaves no place for doubt, all the characters which distinguish the said alkaloid; its subcutaneous injection determines physiological disturbances, but because of not being able to make experiments upon man the Commission could not discover if it is capable of determining symptoms which are analogous to those of cholera.

This is, your excellency, what the Commission have felt it their duty to report as the results of their extensive, difficult, and dangerous labors, thus bringing to a happy realization the desire expressed by your excellency that Spanish military pharmacy should contribute, according to its ability, to the advancement of science; instead of, on the contrary, figuring at the head of certain centers and corporations, they have occupied themselves with the vital and most important question of investigating what may be the cause of cholera, and its corollary the means of annihilating and combating it.

If it has not been possible to arrive at the latter consummation there is the satisfaction of having perhaps made a most important discovery which must receive the praise of humanity and deserve also the recognition of the men of science.

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#### RESEARCHES UPON A CHOLERA PTOMAINE.

By NICATI AND RIETSCH.\*

First, the authors discuss the existence of a cholera ptomaine. Like Pouchet and Villiers, Nicati and Reitsch succeeded always in extracting from bouillon cultures of cholera bacteria and from the intestinal contents of recent cholera cadavers (1-2 hours post mortem), a substance which the accepted chemical reactions showed to be an "alkaloid," and which had a deleterious action on the animals; and on account of the constant presence of the Koch's cholera bacteria in the intestinal canal at the commencement of cholera attacks which present striking appearances of an intoxication, these authors believe themselves justified in admitting the identity of the two alkaloid substances. Furthermore, they do not doubt that in the alkaloid, the presence of which they have demonstrated, the agent is found which causes the grave symptoms of an attack of cholera in man.

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\* Berlin. klin. Wochenschr., 7, 18, 1887.





## CHAPTER IV.

### THE ETIOLOGY OF CHOLERA AND ITS DIFFERENTIAL DIAGNOSIS FROM MALARIA.

#### SECTION 1.

##### PERSONAL OBSERVATIONS CONCERNING THE ETIOLOGY OF ASIATIC CHOLERA.

##### GENERAL REMARKS.

Having first familiarized myself with the characteristics of the comma bacillus of Koch, of Finkler-Prior, of Deneke, and of the Miller and those of the so-called Naples bacillus of Emmerich, by a visit to the Imperial Board of Health at Berlin and to the laboratories of Koch and Miller in the same city, and having provided myself with the necessary apparatus for bacteriological investigations, I proceeded to the theater of the cholera epidemic in southern Europe, spending some time in investigations in Italy, southern France, and Spain, and subsequently continuing them in India.

I made numerous microscopic and culture experiments with the dejecta, vomit, intestinal contents, blood and tissues from cases of cholera in each of these countries, except France. During the course of these investigations I also had frequent occasion to make similar observations in other diseases affecting the intestinal tract. After my return to America I also had the opportunity of making investigations at the New York quarantine station at the time of prevalence of cholera there in the fall of 1887. Since my return home I have also frequently sought for the presence of comma bacilli in the intestinal contents and various organs of patients affected with various diseases.

The results of all these investigations may be summarized by the statement that I have had no difficulty in finding the comma bacillus of Koch present in dejecta and intestinal contents of every case of Asiatic cholera which has come under my observation. I have never been able to find this microbe in the blood or in the tissues or organs outside of the intestinal canal in the human being. On the other hand, I have never been able to find the comma bacillus of Koch present in any other disease. I have, however, occasionally found in the intestinal contents of the healthy human being, and also in various diseased conditions, the presence of a short bacillus which morphologically and under various methods of culture presents characteristics which render it impossible to distinguish this microbe from that claimed by Emmerich as the cause of Asiatic cholera, namely, the Naples bacillus.

In observations since the publication of the discoveries of Koch concerning his comma bacillus, made previous to my commission to investigate cholera, as well as during the conduct of my observations in Europe and India, I have not unfrequently encountered under various circumstances divers species of curved bacilli which morphologically more or less closely resembled the microscopic appearances of the comma bacillus of Koch. Thus I have met with curved bacilli in the secretions of the human mouth during health; curved bacilli in the exudate of human croupous pneumonia; curved bacilli in the scrapings of dysenteric ulcers; curved bacilli in the leucorrhoeal discharges and in scrapings from uterine ulcers; curved bacilli in stagnant water; curved bacilli in water of suspected and unsuspected sources; curved bacilli in running water of various localities, and even curved bacilli floating in the air. But



not once have I been able to meet with in any other cases than those of Asiatic cholera, or anywhere else than in cultures derived therefrom, any curved bacillus which biologically, that is, under artificial culture, has proved to be identical with the comma bacillus of Koch. Furthermore, previous to my investigations concerning cholera I had occasion to observe the presence of curved bacilli in the water of the Susquehanna River, which by a few physicians had been charged with the responsibility of generating an extensive epidemic of typhoid fever in the town of Plymouth in the spring of 1885, and two or three years previous to that date I had the fortune of encountering in a broken-down bouillon contained in a capsule which had been exposed for some days to the air of my laboratory, almost a pure culture of a curved bacillus. And after my return to America I made a thorough examination of all of my bacteriological preparations which had been made previous to my departure, with a view of discovering if possible the presence in any of them of a curved bacillus. I found in a few of these permanently mounted preparations the occasional presence of some scattering curved bacilli, mainly from preparations of intestinal contents and ulcer scrapings in dysentery and preparations of the lochia in cases of puerperal fever. With respect to the curved bacilli found in these old permanent preparations and in the Susquehanna water and exposed bouillon, of course it is impossible in the absence of the evidence to be furnished by essential culture methods to pronounce that any one of these bacilli was or was not identical with the comma bacillus of Koch. But in view of my experience since the employment of the proper culture methods it is extremely probable that these curved forms are to be classed with some one or more of the curved bacilli which belong to species differing from that of Koch.

This personal experience, taken together with the similar experience of other observers in various parts of the world, has forced me to admit that the claim made by Koch must be regarded as established, namely, that the presence of his comma bacillus in the alvine evacuations, or the intestinal contents, or vomit of an individual suffering with a suspicious attack, furnishes a ready, safe, and absolutely reliable means of diagnosis of Asiatic cholera.

Furthermore, as to the etiological relation of the comma bacillus of Koch to Asiatic cholera, the results of my own experiments upon the guinea-pig, made both while in Europe and after my return to America, warrant me in confirming in every particular the pathological power of the comma bacillus affirmed by Koch as the result of the etiological experiments performed by himself and his associates. Moreover, in view of the mass of evidence furnished by the investigations of different experimenters in various parts of the world concerning this same matter, there is also warrant for the declaration that the results of the distinguished German investigator above mentioned have met with confirmation which may be said to be practically universal. The exceedingly few adverse reports have been either invalidated by the retractions of their authors after subsequent experimentation, or have been conclusively overthrown by the work and criticism of others, or can be explained by the fact, amply demonstrated in the evidence contained in this chapter, that the comma bacillus in artificial culture often loses rapidly its pathogenic power. And it may be fairly assumed, in view of this, that those experimenters who have failed to obtain the results secured by myself and others in harmony with Koch have employed weakened cultures in their inoculations. Furthermore, I am convinced, as a result of the evidence furnished in Chapter V, on immunity, that Asiatic cholera belongs to that class of diseases one attack of which confers a certain immunity from a subsequent attack; and in view of the evidence furnished in Chapter VI, on preventive inoculation against cholera, I have also the strong conviction of the probability that inoculation into man of virulent cultures of the comma bacillus of Koch is capable of producing a certain immunity from an attack, and therefore I feel strongly inclined to admit that the comma bacillus of Koch is to be regarded as the real specific cause of Asiatic cholera.

## MORPHOLOGY AND BIOLOGICAL CHARACTERISTICS OF THE COMMA BACILLUS OF KOCH.

The comma bacillus of Koch should perhaps be more properly classed as a spirillum than as a bacillus. Koch himself now is inclined to this opinion, and at present places this micro-organism between the bacilli and the spirilli, as partaking of some of the peculiarities of both. In the human organism this microbe is limited to the digestive tract. It exists in enormous numbers in the intestinal contents in the early stages of cholera, and is especially numerous in cases of extremely rapid development, such as the *foudroyante*. The numbers gradually decrease with the duration of the disease, until they finally disappear, having already become rare when the dejecta begin to present again their natural color and consistence. They swarm in myriads in the serous fluid of the intestinal contents, but are far more numerous in the desquamated flakes of the intestinal epithelium, those bodies which give to the discharges a *rice-water* aspect. They furthermore have been found in some numbers in the lumen of the follicles of Lieberkühn; they have sometimes been found below the epithelia, between it and the subjacent basement membrane, especially of the Lieberkühnian follicles, and occasionally they have been found to penetrate to some distance into the surrounding connective tissue of the intestinal mucosa. It is doubtful if in the human being they ever reach the circulating blood or extend as far along the lymphatic tracts as the location of the lymph glands, and they have never been found in the lacteals, although it should be stated that two or three observers claim to have found them in the arachnoid fluid of the nervous system and elsewhere. Thus in the human subject the habitat of this micro-organism may be said to be limited strictly to the innermost coat and to the lumen of the intestinal canal.

It occasionally happens that the intestinal contents, especially in extremely rapid cases of cholera, contain almost exclusively myriads of the comma bacilli, as shown by the microscopic examination; but in the vast majority of cases these micro-organisms are intermixed with various other species of bacteria in considerable numbers, and often the other bacteria are so numerous in proportion to the comma bacilli that it is difficult to find more than two or three of the latter in a given field of the microscope. (See Ill. No. 17; Photo. No. 1.)

With respect to the examination of the cholera dejecta and intestinal contents, it should be stated that every search made proved the existence in varying numbers of the comma bacilli intermingled with various other bacteria. The results of these examinations led me to the conclusion that while the comma bacilli were invariably present during the early stages of the disease, yet their numbers varied to such a degree as to occasion a doubt of there being any close relation between the numbers of bacilli to be found by the microscope alone and the activity of the disease process, for it frequently happened that, even in the rapid cases reaching a fatal termination in a few hours, but very few of these micro-organisms could be found in the cover-glass preparations; and again, it often occurred that they were seen to be present in great numbers in cases of slower progress and after the disease had continued for two or three days. Furthermore, the comma bacilli were frequently met with in the cover-glass preparations in as large numbers in the upper portion of the intestine—*i. e.*, the duodenum—as in the lower portion of the ileum near the seat of the ileo-cæcal valve. It should also be mentioned that in the contents of the colon these special bacteria were not infrequently met with. It often happened that when scarcely any comma bacilli were to be found in the fluid portion of the dejecta and intestinal contents, they were still to be seen swarming in the epithelial flakes suspended in this fluid, and in these also they were frequently associated with other bacterial forms.

I have spoken of the frequent scarcity of comma bacilli in cover-glass preparations from the intestinal contents and the dejecta of rapid cases. It should be remarked, however, that when the method of plate cultures was resorted to, the gelatine was found to be absolutely swarming in the course of twenty-four hours with innumerable colonies presenting the characteristic appearances of those of the comma bacilli, whilst, on the contrary, colonies of other bacteria which were apparently so numerous in the cover-glass preparations were mingled with them in extremely small numbers. So that we have here an instance of the



uncertainty of the microscopic examination alone for the determination of the presence or absence of the comma bacilli in any instance where they are extremely few or apparently absent in the cover-glass preparations, as also an enforcement of the declarations of the German commission, who most positively insisted in all of their communications bearing on this subject (although this fact seems to have been unexplainably overlooked by some of Koch's most energetic antagonists) upon the absolute necessity of resorting to plate and tube-cultures in flesh-peptone-gelatine for the recognition of doubtful cases of cholera.

The disparity between the results of examination by the microscope alone of cover-glass preparations and those obtained by resort to the method of plate culture seems to warrant the presumption that the special micro-organisms of Koch may possibly exist in the intestinal fluids under some other form than that of the now well-known comma bacillus; in other words, that from this disparity there may be reason to believe that one or more phases of existence of the comma bacillus may have been overlooked by the German observers. Otherwise, it is extremely difficult to explain why it is that in cover-glass preparations, at times, scarcely two or three curved bacilli may be met with among hundreds of other forms, whilst, on the contrary, the plate cultures prove that in the very specimens from which the cover-glass preparations were made the seeds (whatever shape they may assume) of these comma bacilli were present in millions. We shall recur to this question later on.

Examinations of the vomit of cholera patients frequently revealed the presence of the comma bacillus in that fluid. This statement is somewhat in discord with the announcement of the German commission, wherein the statement is distinctly made that the vomit rarely contains it. I may say that in the proportion of three cases out of five I have been able to recognize comma bacilli in this fluid, as well in the cover-glass preparations as in the plate cultures, although this fluid had usually a decided acid reaction.

With respect to the chemical reaction of the media in which comma bacilli will or will not grow, I should perhaps state here that my observations are not in entire accord with those announced by the German commission, for I have after repeated trials not infrequently succeeded in obtaining cultures of the comma bacilli in slightly acid flesh-peptone-gelatine both in plate and tube cultures. Whilst there is no doubt that media of a neutral or slightly alkaline reaction are generally most favorable for the life and development of the comma bacilli, as well as of most other forms of bacteria, yet it appears to be certain from my own observations, as well as from those of a few others, that the comma bacilli will occasionally, although slowly, grow in media which are otherwise favorable but have a slightly acid reaction. In this respect I am in accord with Klein, Miller, D. D. Cunningham, and some others.

Photo. No. 1 is a photo-micrograph of the intestinal contents of a typical case of asiatic cholera. By reference to this it is seen that there are not more than two comma bacilli present in the microscopic field represented, whilst the other bacteria are far more numerous. In those cases where the comma bacilli exist in the intestinal contents in nearly pure culture and but little intermixed with other bacteria, microscopic examination alone is sufficient to base a diagnosis upon. But in such cases as those represented by the photo-micrograph above mentioned microscopic examination alone can easily mislead. The very few curved bacilli found may possibly not be those of the comma bacilli of Koch, since there are numerous other curved bacilli which more or less closely resemble morphologically those of cholera infectiosa. In these cases, and in fact in the vast majority of instances, for the purpose of diagnosis it is safe only to resort to culture methods for the certain recognition of the comma bacilli of Koch, and the procedure is then as follows: A series of three test-tubes containing neutral or slightly alkaline sterilized flesh-peptone-gelatine are inoculated with a minute quantity of the intestinal contents as evacuated from the bowels, and plate cultures are made from each after the manner described in detail in the preceding article above mentioned. After 24 or 48 hours it is usually found that the colonies developing from the micro-organisms contained in the intestinal contents are almost all those of the comma bacilli of Koch. For some reason not well determined it is found that under such circumstances few other colonies will develop in the gelatine, so that, notwithstanding the abundant intermixture of various other bacteria in the

intestinal contents itself, the gelatine plate shows almost a pure culture of the comma bacilli. This was, in fact, the case with the intestinal contents represented in Photo. No. 1, above referred to. After 24 or 48 hours a microscopic examination under a low power, say 50 diameters, of the gelatine plate shows the comma bacilli colonies presenting the appearance represented in Photo. No. 2, which is a reproduction of a photo-micrograph of a colony in a gelatine plate made from the intestinal contents represented in Photo. No. 1. By reference to Photo. No. 2 the following peculiarities of the aspect of the comma bacillus colony will be noted. There is a rough granular center of a gray or brownish-yellow aspect, having the appearance of a collection of highly refracting, finely-broken glass, surrounded by a clear circular zone in which are a few scattered, dark, refracting granules. This colony really rests at the center of the bottom of a saucer-like cavity depressed below the general surface of the surrounding solid gelatine, and containing clear fluid. In their development the colonies of comma bacilli have the faculty of liquefying the surrounding gelatine. It is necessary to wait until the development of the colony has sufficiently far advanced to produce this liquefying effect in order to be sure that one has under observation a genuine colony of the comma bacilli of Koch; for in the earliest appearance of the cholera colonies the surrounding ring of fluid is so narrow as to escape observation, and there are bacteria which in their development in flesh-peptone-gelatine plate-cultures present a granular aspect so nearly resembling that of the central portion of the comma bacillus colony as to make it impossible or at least exceedingly difficult to distinguish between them. Photo. No. 6 represents a colony of a micrococcus sometimes found in the air; the aspect of this colony is like broken glass also. This latter colony, however, as may be seen, is more or less regularly circular in outline, and by reference to Photo. No. 2 it is observed that the outline of the comma bacillus colony is quite irregular; in fact, it is often found to be much more irregular than here seen. In the earlier stages of development of the comma bacillus colonies, however, their outlines are more or less regularly circular, and they are then difficult to differentiate. It is necessary to proceed a step further in the examination of the comma bacillus colony in the plate culture before becoming assured of its character. A microscopic examination of the individual bacilli constituting the colony must be made, and it is well in addition to make an inoculation from such an individual colony into a test-tube containing solid flesh-peptone-gelatine in the manner described below. After 24 or 48 hours, the puncture made by the inoculating-needle shows along its track a growth of bacteria more or less advanced, according to the length of time which has elapsed since the inoculation and according to the temperature to which the test-tube has been subsequently exposed.

Photo. No. 32 is a photograph, natural size, of such an inoculated gelatine tube, 48 hours after inoculation. The surface of the solid gelatine within the tube is seen to be inclined. The culture now presents quite a characteristic aspect. The upper portion of the culture is more or less funnel-shaped with the appearance of an air-bubble at the top. The fluid contained in the funnel-shaped cavity beneath the apparent air-bubble (which latter in reality is an optical illusion, the portion of the funnel represented by the air-bubble being only an empty cavity containing air) is clear or slightly opalescent. At the bottom of the funnel and along the narrow neck below is deposited a grayish, finely-granular mass, consisting of the subsided bacilli. Microscopic examination must be made under a high power of the individual bacilli constituting the colony.

The bacteria are so minute that their examination taxes the utmost powers of the microscope both in magnification and in definition; consequently, the best instruments in every respect are required. The microscope must be exceedingly firm, with a steady, stiff stage; the substage illumination must be of such a character as to pass a great flood of light upward, through, and around the object. Although it is possible to see many of the larger forms of bacteria with the old style dry objective as weak as a quarter, if it have excellent defining and resolving powers, yet such a lens is at best an extreme tax on the eye, and, moreover, there are many of the minute forms which are practically invisible under such a lens. The immersion objectives are essential for bacteriological investigations, and those of a homogeneous oil-immersion systems are greatly to be preferred. The focal length should be from a twelfth to



an eighteenth of an inch, with a good working distance and high angular aperture. Among the best of the cheaper lenses of such a character are the Leitz twelfth oil immersion and Reichert fifteenth oil immersion. Among the best of the high-priced objectives, those of Powell and Leland oil immersion sixteenth and of Zeiss or Spencer oil immersion twelfth or eighteenth may be preferred. The very best lens which can be obtained at the present time for bacteriological work is the new Zeiss system oil immersion apochromatic. It is quite expensive, but in resolving and defining power is a wonderful advance over the best oil-immersion lenses heretofore made. It may be stated that there are also a few water-immersion lenses of a short focus and high angular aperture which can be used with more or less satisfaction.

The best substage illuminating apparatus above referred to is that devised by Abbé, which is somewhat expensive. But there are numerous cheaper modifications of this apparatus which work satisfactorily. Perhaps the simplest form, constructed after the design of the writer, is that which consists essentially of an upper hemispherical lens a half inch in diameter, flat surface upward, and a lower biconvex of 2 inches focus, and a diameter of an inch, suitably mounted in a cylindrical holder, which slides up and down below the stage of the microscope. Such an apparatus can be made in this country for the sum of \$6, and gives satisfaction in its use.

It should be stated in connection with the substage illuminating apparatus that in the examination of bacteria it is desired to obtain the greatest flood of light possible, quite contrary to the use of the substage condenser for ordinary histological purposes.

There are two convenient methods of making cover-glass preparations :

(a) The fresh fluid containing the bacteria to be examined is spread out over the surface of a perfectly clean cover glass and allowed to evaporate partially. After the drying has progressed somewhat, but while the film is still moist, a drop of the dilute color solution selected is placed upon the film, and the cover glass is inverted upon an ordinary object-slide. The bacteria, surrounded by the staining fluid, may be directly observed under the high power of the microscope, a certain amount of the coloring-matter having been already absorbed by the bacteria. This method allows the motile bacteria to be observed while in motion, and in certain cases is advantageous to employ.

(b) The dried film fixed upon the surface of the cover glass by the agency of gentle heat after the manner already described is best stained by placing a drop or two of the color fluid upon the film and inverting the cover glass upon an object-slide. After the film has thus been subjected for a few moments to the action of the color solution the latter is drawn off by capillary attraction in the following manner: A drop of sterilized distilled water is placed at one edge of the cover glass, and at the opposite edge a small piece of bibulous paper is placed in contact with the color fluid, which is thus drawn off, and at the same time replaced by the clear distilled water at the opposite side. The same method may be made use of for removal of the coloring fluid in the case of the bacteria examined before complete desiccation, as above described, and is especially useful where films of non-albuminous liquids can not be fixed upon the cover glass by the agency of heat. Occasionally it may be found beneficial to use in place of simple distilled water that which has been rendered slightly acidulated by the addition of acetic acid (one drop to a half-ounce or more, according to circumstances).

After the coloring-matter has thus been washed out the object may be at once examined under the microscope, or the film may be prepared for permanent mounting in the following manner: The cover glass may be slid sideways to the edge of the object-glass and gently withdrawn. The water is then allowed to drain off the surface by resting the cover glass in a more or less vertical position upon a small piece of bibulous paper. In a few moments the film becomes dry. Or the dehydration may be expedited by plunging it for an instant in strong alcohol, which latter is also to be drained off in a similar manner; but frequently the use of alcohol for this purpose is objectionable because of its decolorizing power. In many instances the bacteria lose, even during treatment for such a short time by alcohol, a considerable amount of color.

After the film has become quite dry it may now be permanently mounted; and the best mounting medium for the permanent preservation of bacteriological specimens is perhaps Canada balsam, preferably dissolved in xylol. The tendency of all objects, including bacteria,

stained with the aniline dyes is to become decolorized in the course of time, and after a few months to a few years the coloring which originally may have been quite intense may be found quite faint, or to have entirely vanished, and this tendency is increased by the existence in the washing fluids or in the permanent mounting-medium of substances which naturally have the power of decolorizing. For this reason, in the processes used in preparation of bacteria it is always well to avoid, unless absolutely necessary, the use of acids and of most of the volatile and essential oils.

If the microscopic examination both of the plate colony and of the material of the gelatine-test-tube culture shows only curved bacilli, it may at once be inferred that one has to do with a case of genuine cholera infectiosa. In order to be absolutely certain of this, however, at the same time that the gelatine-tube culture is made from the plate colony the surface of a potato prepared after the manner indicated below should also be inoculated from the same colony, and the potato should be placed for 24 hours in the culture-oven. A growth consisting of curved bacilli upon the potato is positive proof that the bacilli are none other than those of cholera infectiosa. In this case we certainly can not have to do with the curved bacilli of Finkler and Prior, for the appearance of the gelatine plate or tube colony of the latter bacilli is so markedly different from that of the comma bacilli of Koch that there can ordinarily be no mistake. It is only for the purpose of distinguishing between the Koch and the Deneke bacilli that the potato culture is now resorted to; the latter curved bacillus will not grow upon this medium whilst the former will, especially if the potato be kept in the incubator after inoculation. For this purpose the potato is prepared in the following manner:

Firm potatoes are selected, free from specks, their skins well scrubbed with a stiff brush, the eyes containing particles of earth are picked out, the potato is immersed for 20 minutes to half an hour in a solution of corrosive sublimate (1 part to 1,000), taken therefrom and placed in a colander with a freely perforated bottom, subjected for an hour to the action of steam in the steam-sterilizer, then allowed to cool, after which blades of common knives (a sharp table knife with a wooden handle answers the purpose well) are thoroughly sterilized by holding in the flame of the Bunsen burner, and allowed to cool. The hands are now well washed and dipped for a few moments in a solution of corrosive sublimate, 1 part to 1,000. The potato is now firmly grasped between the first two fingers and thumb of the left hand and evenly divided with the sterilized blade of one of the knives. Each half is placed in the moist chamber with the cut surface up, care being taken in this maneuver that nothing shall come in contact with the cut surface. The potatoes thus prepared are covered as quickly as possible with the bell-glass, in order to limit exposure to the surrounding air. The middle of the cut surface of the potato thus prepared may now be inoculated with the platinum wire and set aside for development. The latter may take place at the ordinary surrounding temperature, or in the culture-oven, as may be desired. Many of the bacteria will be found to have a more or less characteristic growth upon this culture medium, and for a few of them indeed it offers the only known ready means of making a differential diagnosis. After some days, however, growths of fungi which have fallen from the air are apt to appear upon the surface of the potato, and thus frequently interfere with the observation. In order to obviate this, a modification of the potato-culture method has recently been introduced by Meade Bolton. A number of large test-tubes an inch in diameter are required. A long cylindrical punch of an inner diameter slightly less than that of the test-tube is needed; this also should be sterilized. A number of fresh potatoes are carefully selected, the two ends cut off with a sterilized knife. A plug is now punched out from the center by means of the punch. This plug is divided by a sterilized knife in such a manner that the knife passes from one corner at the top obliquely downward to the opposite corner at the bottom. Each of these halves is placed in a test-tube with the thick end at the bottom. After a sufficient number of test-tubes have been thus filled, they are sterilized by subjecting them for an hour to the action of steam in the steam-sterilizer. This may be repeated once or twice on successive days. The potatoes are then ready for culture, and the inoculations are to be made upon the middle of the inclined surface by means of a platinum needle. It is found that this method of potato culture not only secures greater protection from



accidental contamination of the culture medium, but the growth of the inoculated bacteria can be closely watched from time to time directly through the walls of the tube.

Photo. No. 11 is a photo-micrograph of a cover-glass preparation made from the colony represented in Photo. No. 2, which was obtained from the intestinal contents represented in Photo. No. 1. By reference to Photo. No. 11 it will be seen that we have a pure culture of curved bacilli. The forms here shown are in the main those of a simple curve in one direction; but there are numerous instances of a figure **S**, caused by the juxtaposition or attachment end to end of two bacilli curved in opposite directions. Under cultivation the comma bacillus of Koch is not always found presenting exactly the morphology here shown. Growths in certain media, especially those not most favorable for the development of the bacillus, show more or less numerous threads of a more or less spiral form. These spirilli may be more or less jointed, and consist of a spiral chain of a number of individual curved bacilli joined end to end more or less closely, or they may present the appearance of a continuous curved or spiral filament without interruption. The spiral forms which often develop in cultures of the comma bacillus, and in fact of all other curved bacilli heretofore cultivated artificially, are well represented in Photo. No. 13, which is a photo-micrograph of a cover-glass preparation from a pure culture of the curved bacillus of Finkler (so-called of *cholera nostras*). Photo No. 15 also shows a few examples of short spirilli in a pure culture of the Deneke or cheese bacillus. Comparison of these photographs with that reproduced in Photo. No. 11 also shows the morphological resemblance of the individual curved bacilli of Koch, Finkler, and Deneke. Other curved bacilli—such as those of the mouth, one form of which was isolated and cultivated by Miller, those sometimes found in intestinal contents in cases of dysentery, those frequently found in leucorrhœal discharges, those occasionally found in scrapings from pneumonic lungs, those often found in ordinary running water and in numerous other places—also so closely resemble the comma bacillus of Koch morphologically that it is impossible or at least unsafe to undertake to distinguish between them by means of the microscope alone for the purpose of recognition except under the circumstances above mentioned. For distinction between the curved bacilli of cholera infectiosa and other curved bacilli it is a *sine qua non* that plate cultures, tube cultures, and potato cultures be resorted to in addition to microscopic examinations.

#### METHOD OF PREPARING CULTURE MEDIA.

*Solid culture media.*—Solid culture media may be either transparent or opaque.

Of the transparent culture media that containing animal gelatine is most generally used, and a stock of it is best prepared in the following manner: A sufficient quantity of meat juice has already been strongly boiled until the albumen is thoroughly coagulated. The best gelatine obtainable is added in the proportion of 5 to 10 per cent. (The stronger percentage should be employed in warmer weather.) Before adding to the fluid, which should be cold, the gelatine is to be chopped into fine pieces; it is then soaked in the cold fluid for half an hour or more until it has become well swollen; the whole is then gently heated until the gelatine becomes thoroughly melted. The peptone and salt are then added in the proportion already mentioned, and the mixture is neutralized with a strong solution of sodium bicarbonate. Care should be taken to have the reaction faintly alkaline rather than at all acid, as many forms of bacteria will not grow well or develop at all in acid culture media. It is well, however, for the cultivation of certain germs to provide a stock of slightly acid culture media, both fluid and solid. This mixture is now well boiled for 30 minutes and filtrated through strong filter-paper previously well sterilized in the sterilizing-oven, the funnel supporting the filter having been also thoroughly sterilized. Before the mixture is poured upon the filter the latter should be moistened with a small quantity of hot sterilized distilled water, and it is necessary that the filtering should be done while the fluid is very hot. In fact, in filtering through filter-paper it is advisable that the funnel should be surrounded by boiling water in a vessel properly formed to receive the funnel. The filtration, however, can usually be satisfactorily performed without such an apparatus if instead of the filter-paper fine sterilized absorbent cotton is used.

In this case the funnel must be kept quite warm by throwing the flame of a Bunsen burner around it frequently. The filtered fluid is to be directly collected in a number of large sterilized flasks and a stock of it constantly kept on hand. For immediate use, a convenient number of test-tubes are one-fourth to one-third filled by means of a sterilized pipette. It is sometimes found that the mixture thus obtained is not quite clear, and this can be determined from the first flow of the fluid through the filter. In this case it is necessary to stop the filtration and clarify the mixture by the addition of the white and shell of an egg. This albumen should not be added until the fluid has first become cool. It is to be thoroughly disseminated throughout the mixture by shaking well, and the whole again subjected to hard boiling for a few minutes. It should be stated here that these boilings are best done in the steam-cylinder. After the egg albumen has completely coagulated the mixture is again filtered in the manner just described.

It is finally necessary to sterilize the filtered fluid, and this is done by placing the various vessels containing it in the steam-cylinder for 10 to 15 minutes on 5 or 6 successive days. In the interim the vessels should be kept in the culture-oven at a temperature of 35° C. The remark previously made should be repeated here, that whenever any of the stock material is removed from the flasks containing it it is necessary to sterilize again that which remains, in order to prevent development therein of bacteria which may accidentally have found access while the cotton plug has been removed.

*Tube cultures.*—Test-tubes containing flesh-peptone-gelatine thus prepared are used for culture in various ways. The most common use is to inoculate them with pure cultures of bacteria by means of a puncture with the point of a platinum wire extending into the depth of the gelatine. This is called a *tube culture*.

*Plate cultures.*—Another and the most important use of this gelatine culture medium is that introduced by Koch for obtaining pure cultures from mixtures of various species of bacteria. The procedure is as follows: Three gelatine tubes are taken and the contents rendered fluid by gentle heat; after the fluid gelatine has descended to the temperature of body heat one tube is inoculated, by means of a previously sterilized platinum needle, with a loopful of the material containing the various bacteria in question; after the inoculation the tube is again immediately plugged and the fluid well but gently shaken, in order to diffuse the germs thoroughly and evenly throughout the fluid mass; from this, while still fluid, another of the three tubes is inoculated by transferring into it with the platinum wire loop three droplets in the manner indicated. The second tube is then immediately plugged and well shaken, after the manner of the first. The third tube is inoculated from the second in the same manner. Thus it is seen that in the second and third tubes the original inoculation material has become greatly diluted. A sterilized glass plate is now carefully withdrawn from the metallic case in which a number have been sterilized, care being taken to seize it by the edges between the thumb and finger; this is placed upon the ground-glass plate of the cooling apparatus, in which ice is used, and immediately covered with the bell-glass; in a few moments the glass plate has become sufficiently cold, and the gelatine from the first test-tube is now poured upon it and spread out, either by means of the lip of the tube or a sterilized glass rod, in an even layer in the form of an oblong square, care being taken that the fluid does not extend to the edge of the plate, and the latter is again quickly covered with the bell-glass. In pouring the fluid from the test-tube care should be taken that upon removing the cotton plug the inner surface of the lip is well wiped. The external surface of the lip should be exposed for an instant to the flame of the Bunsen burner, but the fluid should not be poured out until the lips have become sufficiently cool, otherwise many of the germs contained in the inoculated tube may be killed by the action of the heat as the fluid flows out. On the cooling box in a few moments the layer of gelatine has become solid. The fluid contained in the other test-tubes is spread upon sterilized glass plates in a similar manner. These three plates are placed in regular succession upon the benches in the moist chamber and set aside for development.

This flesh-peptone-gelatine becomes fluid below the body temperature (at about 80° F.), and if it is desired to be kept solid during the growth of bacteria it can not be subjected to the



heat of the culture-oven. The surrounding room temperature is sufficient for the development of most of the germs which will grow in this medium. High summer heat is frequently sufficient to melt the gelatine, and at these times this medium is not usually available for solid cultures, unless the culture-oven be used as a cooling-box, in which the temperature is lowered by means of ice.

In quickly solidifying, the germs dispersed throughout the layer of gelatine upon the plate are fixed in the position in which they may happen to be caught at the time, and from each one capable of development a colony of its own species will be formed. It will be found that these colonies, visible under a low power of the microscope (fifty diameters) or to the naked eye, will have developed in thirty-six to forty-eight hours, or more, and it will be seen that in one of the gelatine plates the colonies are sufficiently distant from each other to permit of inoculations from one by means of the point of the platinum wire without danger of accidental contact with any of the others. This plate is now used for making *pure cultures*. A number of solid gelatine tubes at hand are inoculated from the different colonies and set aside for development, and if sufficient care has been exercised in the procedure it will be found that each tube contains a perfectly pure culture.

*Object-glass cultures.*—Instead of pouring the inoculated fluid gelatine from the tube upon a large glass plate in the manner described, a few drops of it may be withdrawn by means of a sterilized pipette and spread upon an ordinary object-glass which has been previously sterilized. The layer thus formed after solidification may be placed in the moist chamber for development, and the growth of isolated colonies may thus be watched under the microscope from time to time.

A device which is now frequently used for plate cultures is even better than that just described. After the gelatine has been poured upon a plate a mat with a large perforated center is cut out of stiff paper one-eighth of an inch thick, the outer edge of the mat having the same dimensions as the plate. This mat, which has also been sterilized, is placed upon the plate and another plate is clamped upon it. Thus we have a closed shallow chamber formed, capable of being placed upon the stand of the microscope for low-power examination.

*Roll-tube cultures.*—A modification of the plate culture, exceedingly valuable for many purposes, is that devised by von Esmareck. After the three gelatine tubes have been rendered fluid and inoculated in the manner above described, instead of the contained fluid gelatine being poured out upon a glass plate in order to form a plate culture, each tube is rolled quite rapidly in a horizontal position in ice water the cotton stopper having been previously covered with a rubber cap to prevent the cotton from imbibing the water. In this way the gelatine is made to spread over the walls of the tube in a thin and regular layer. The isolated colonies will develop in this layer and present the same aspects as in the usual form of plate culture. The advantage is that the gelatine can thus be perfectly protected from accidental inoculation by bacteria of the air, for it is not necessary to remove the stopper after the intended inoculation. Agar-agar can be used in the same way for *roll cultures*. Instead of the inoculated tubes of fluid gelatine being immersed in ice water, they can be advantageously rolled in a horizontal position on a block of ice to solidify them.

Anaërobic bacteria will not grow when exposed to free air. A very simple mode of plate culture of anaërobic bacteria is the following: The surface of the gelatine upon the glass slide or upon the glass plate may be covered in whole or in part by extremely thin sterilized mica plates and thus protected from the air, when such bacteria may have an opportunity for development, in which case the colonies can be satisfactorily examined under the microscope, or used for obtaining pure cultures in the usual manner.

Another use of the gelatine layer upon the glass slide has already been alluded to and is as follows: A sufficient quantity of sterilized flesh-peptone-gelatine is removed with a sterilized pipette and poured upon the surface of the glass slide and allowed to solidify. The gelatine is then inoculated by scratches with a platinum wire carrying the desired microbes, after the method of Brefeld, already described. The slide is then placed in the moist chamber for development and subsequent examination.

Plate cultures are, however, used for other purposes than separation of mixtures of different species, chief among which is the differentiation between colonies of different species by means of certain characteristics of growth. (Photos. Nos. 2 to 7.) For this purpose the gelatine plates are much more useful than solid gelatine tubes. It was soon found by Koch in using this method of isolation of bacteria that many of the different species presented certain distinguishing characteristics in the aspect of colonies developed in the gelatine. As an example, some species while developing in such a medium render the gelatine fluid, others do not possess such an influence. Furthermore, certain species spread more or less widely over the surface of the gelatine, while others are heaped up upon it within narrow limits. Again, some of the colonies present regular circular outlines, other irregular. Some of them are more or less coarsely granular, others finely granular, still others more or less glairy, others powdery. Some present one color, some another, many are colorless. Some have the power of rendering the neighboring gelatine fluid, while developing evenly throughout the fluid mass, thus rendering it cloudy; others are limited more or less to the center of the fluid portion, being surrounded by a fluid border entirely limpid. Some possess the power of disseminating a characteristic color in a narrow zone surrounding the developing colony, and so on. Thus the differences between many species are more or less marked and characteristic, so that for the recognition and differential diagnosis of numerous species of bacteria the gelatine plates furnish most valuable means. The aspects of pure cultures of these species are frequently characteristic also in gelatine-tube cultures. (Photos. Nos. 29, 30, 31, 32, 33, and Figs. 1, 2 of Ill. No. 21.)

The appearance of gelatine-plate colonies of the curved bacillus of Finkler is shown in Photo. No. 4, which is a reproduction of a photo-micrograph of such a plate colony. As is seen, the outline of the colony is regularly circular, its aspect is finely granular, and its color is yellowish-gray. The appearance of the gelatine-tube culture of the curved bacillus of Finkler is represented in the two tubes to the right in Ill. 21, Fig. 2, as compared with the appearance of gelatine-tube cultures of the curved bacillus of cholera infectiosa, shown in the two tubes to the left in the same photo. The curved bacilli of Finkler also have the power of liquefying gelatine, but in their growth in 10 per cent. gelatine there is no appearance of an air-bubble at any time, but development is far more rapid than in the case of cholera infectiosa, and the fluid contained in the liquefied portion completely fills the cavity, and is of a homogeneous opaque aspect. The curved bacillus of Deneke in its growth in the gelatine plate forms a colony which also has the power of rendering the surrounding gelatine fluid, and the aspect of the colony at times considerably resembles that of genuine cholera. But its development is much more rapid, the fluidification of the gelatine proceeds with much greater speed, and the zone of fluid surrounding the central colony which rests in the bottom of the saucer-like depression is not usually clear, but more or less cloudy. The growth in the gelatine tubes is funnel-shaped, and there is an apparent air-bubble at the top. When, however, resort to the potato culture is had, it is found that the comma bacillus of Koch grows abundantly upon it at normal room temperature and in the culture-oven, while that of Deneke refuses to grow. Photo. No. —, represents a number of gelatine-plate colonies, which do not render the surrounding gelatine fluid, of a curved bacillus morphologically identical with that of cholera infectiosa, isolated by the writer from the water of a well which constituted the common water supply of a small village in Sicily where an outbreak of cholera had occurred. It was suspected that this well had been contaminated by drippings from wash-tubs in which the clothing of cholera patients had been washed, near the margin of the well. It is sufficient, as these photographs indicate, to cultivate these different organisms in gelatine plates in order to distinguish readily between them.

Microscopic and culture examinations were also made of the water from various sources, such as well water within the city of Palermo, well water used by the people in the village of Belmonte, 15 or 20 miles distant from Palermo, where they were having an outbreak of cholera, water from various open conduits supplying the city of Palermo, and water of the harbor of Palermo. Among the specimens of well water from the city of Palermo was some taken from a well within a court where the first cases of cholera appeared in that city. The well had



been closed and placed under guard, and the examination was made some three or four weeks after the well had been closed. No comma bacilli were found in this well or in any of the others in the city of Palermo. But in the water taken from the well at Belmonte various species of bacteria were found. Among these may be mentioned some which by the shape of the colonies and by the morphological characters of the bacteria constituting them somewhat closely resembled the Naples bacillus of Emmerich, and some also whose colonies presented a peculiar aspect possessed a regular border and appeared to be formed of concentric rings surrounded by a narrow border of apparently fluid gelatine. The color of these rings varied from a light to a dark brown and their aspect was somewhat finely granular. The bacteria (those mentioned in the last paragraph) constituting these concentric colonies were identical in form and very near in size also to those found in the characteristic colonies of the comma bacillus of Koch; but the tube cultures made from these concentric colonies (Photo. No. 5) differed as much from the characteristic tube cultures of the comma bacillus of Koch in their shape as they differed in the plate cultures. In the tube cultures of these concentric colonies very little, if any, fluidification of the gelatine either in the track of the puncture or around the border of the portion growing at the surface could be seen.

As to the harbor water of Palermo, specimens were taken near the mouths of several of the main sewers where the sewage was emptied into a portion of the harbor called La Cala. Microscopic examinations of cover-glass preparations from this water showed many various forms of numerous bacteria and few curved forms which were usually larger and perhaps less curved than the comma bacilli of Koch. Plate cultures made from the same water showed no colonies whatever presenting the peculiar characteristics of the comma bacilli of Koch. There were numerous colonies, however, which rapidly rendered the gelatine fluid of a dark-brown color, usually circular in outline, sharp bordered, and of a coarsely granular aspect. Inoculations of gelatine tubes made from these latter colonies were followed by exceedingly rapid growth of the bacteria. Within the first 24 hours the naked-eye appearance of these tube cultures was very similar to that of the comma bacillus of Koch. There was the same funnel-shape depression of the surface of the gelatine at the top of the puncture and the same appearance of the air-bubble, so familiar in the tube cultures of the comma bacillus. So far as the naked eye could determine between the tube cultures of these two organisms the chief difference consisted in the rapid development of these colonies from the La Cala water. At the end of 48 hours the rapidity of development of the La Cala colonies was such as to no longer leave any doubt concerning the possible identity of the two even by the naked eye alone. At the end of this time the top portion of the colony had so rapidly extended laterally as to involve the whole surface of the gelatine, rendering it quite fluid, and the growth of the colonies along the track of the puncture in the depths of the gelatine by that time began to assume the appearances of gelatine-tube cultures of the Finckler and Prior bacillus; *i. e.* the track of the puncture was very much widened and filled by a fluid which was opaque and evenly cloudy throughout without any deposits of granules along the sides. Twenty-four hours later the tube cultures had lost every resemblance they originally had to the cultures of the comma bacillus or to those of Finkler and Prior. Furthermore, microscopic examination of cover-glass preparations made from these tube cultures of the La Cala water showed the presence of thick straight bacilli with rounded ends and a length more or less variable. The shortest resembled to some extent oval cocci, and in this stage of their growth were somewhat similar in form and size to the Naples bacillus of Emmerich. Cover-glass hanging drop cultures of these same straight bacteria after being exposed for 24 hours to a temperature of 37° C. in the incubator showed nothing but rods of a decided length mixed with numerous filaments, which often extended across the whole width of the field of the microscope. The presence of spores was noticeable in some of these long filaments.

I was in Palermo at the time of the departure of Drs. Emmerich and Buchner from that place, and Dr. Coppola, of the chemical laboratory of the University of Palermo, kindly gave me some tube cultures in gelatine from pure cultures of the Emmerich-Naples bacillus, which he had directly obtained from Professor Emmerich during the time of that gentle-

man's investigations in Palermo. At the same time I obtained some gelatine tube cultures from the same source which had directly descended from the Naples bacillus which Emmerich had discovered during the previous year while investigating cholera in Naples. After familiarizing myself with the morphological and biological characters of the Naples bacillus thus obtained I undertook the search for it in the cholera patients. I made numerous attempts to find it in the blood of the cholera patients in all stages of the disease as well as in the dejecta and vomit. My examinations of the blood were constantly negative, notwithstanding the fact that in addition to direct microscopic examination by cover-glass preparations I invariably resorted to the method of gelatine-plate and tube cultures also. So far as the dejecta are concerned, I may mention that bacteria presenting an identity of morphology and of appearances to those of Emmerich, both in the plate and the tube cultures, were not infrequently met with.

In respect to the occurrence of the comma bacilli of Koch in the tissues of the wall of the intestine, I may say that my observations, although they were in a few instances followed by positive results, can not be absolutely regarded as confirmatory of the statements of the German commission with regard to the frequency of the occurrence of these organisms in the intestinal wall. In thin sections of the ileum and also of the duodenum, I have never found the comma bacilli of Koch present in those from the upper portion of the intestine, whilst I have with extreme rarity found them in small numbers in some of the sections made from the lower portion of the ileum. In these sections curved bacilli were sometimes found within the lumen of the crypts of Lieberhühn and between the epithelial lining these crypts and the basement membrane forming the wall, as also occasionally in the submucous connective tissue in their neighborhood.

I may say here that what has been stated concerning the comma bacillus of Koch and other micro-organisms applies equally well to the results of my observations in Spain and India concerning the relations of the comma bacillus to Asiatic cholera. In this connection I should, perhaps, remark that I have frequently seen curved bacilli which by their morphology alone might possibly be regarded as very similar or identical with the comma bacillus of Koch under a great variety of circumstances and in many places where there could be no possible question of the existence of cholera. As I have already stated, I have frequently met with them in the intestinal contents and discharges of ordinary diarrhoea, in the materials scraped from the intestinal wall, in cases of dysentery, and in cases of death from phthisis where there had been abdominal complications. I have met with them in the purulent discharges from the uterus; I have even met with them frequently in ordinary human saliva; I have often met with them in scrapings from the lungs in cases of death from croupus pneumonia; I have found them in well water, river water, fluids contaminated with faeces, in decomposed beef broth exposed to the ordinary air of the laboratory, and, in fact, under many other circumstances. Many times microscopic examination alone would have been utterly impossible to have distinguished them from genuine comma bacilli of Koch as found in Asiatic cholera. Many times, however, such as in cases of diarrhoea and dysentery and in the leucorrhoeal discharges, the morphology of the curved bacillus alone was sufficient to distinguish it from the curved bacilli of Koch, and in no case when the method of plate and tube cultures in flesh-peptone-gelatine was resorted to, as it was in many instances, has there been the slightest difficulty in distinguishing these various curved bacilli from those met with in Asiatic cholera.

Dr. Theobald Smith, of the Bureau of Animal Industry, at Washington, informs me that during April, 1889, he found in cover-glass preparations from the intestinal wall of several pigs, affected with hog cholera, comma bacilli in large numbers intermingled with numerous very delicate true spirilla. The comma bacilli were found, more particularly in small superficially necrotic areas (ulcers) of the lower colon. Subsequently they were also encountered in the ulcerated mucosa of the stomach. When isolated by means of agar plates and studied in pure cultures they did not seem to differ microscopically from the comma bacilli of cholera Asiatica either in form or motility. They were, however, at once distinguished by the fact that they fail to liquefy gelatine, upon which substratum they grow rather feebly. Among



other biological characters which need not be mentioned here is their more abundant growth in bouillon peptone which has not been neutralized (and hence has a slightly acid reaction) than in bouillon made slightly alkaline with sodium carbonate.

Dr. Sternberg informs me that in his bacteriological studies of the feces of yellow fever patients (about fifty) he has never encountered any curved bacilli, or spirilla, corresponding with the "comma bacillus" of Koch. During the recent epidemic at Decatur, Ala., he gave special attention to the liquifying organisms present in the feces of yellow fever cases at different stages of the disease, and isolated in pure cultures several different liquifying bacilli, but, as stated, did not encounter any resembling Koch's bacillus (spirillum) of Asiatic cholera.

In the experience of the author in the examination of the intestinal contents of cholera infectiosa at the quarantine station in New York and at various places in Spain, France, Italy, Sicily, and India the comma bacillus of Koch has been invariably present, whilst none of the other curved bacilli have been found therein. He has compared its biological characters with those of all other curved bacilli known, and he has no hesitation in affirming his opinion that none of them are identical with it.

Various methods of recognizing the presence of the comma bacillus of Koch without resort to the microscope and to plate cultures have been proposed for practical use, such as those of Bujwid, Buchner, Schottelius, Gruber, Brieger, and others (see this chapter); but in our opinion however valuable they may be in exceptional cases as supplementary to those above described they should by no means be substituted in the place of the latter.

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#### *PATHOGENIC QUALITIES OF THE COMMA BACILLUS OF KOCH.*

The first cultures of the comma bacillus I had the opportunity of personally obtaining from cases of cholera were those made from the dejecta, vomit, and intestinal contents of patients suffering from the disease in the city of Palermo, in the island of Sicily, towards the latter end of October, 1885. I kept alive pure cultures of this microbe, as well as pure cultures of various others which I had obtained in the course of my investigations in that city, until my return to Berlin, in the middle of the spring of 1886. The next material which I freshly obtained from cholera cases dated from the early part of the winter of 1886, and was taken from cholera cases in Spain. Pure cultures of these were also kept alive until my arrival at Berlin, at the time above mentioned. After obtaining pure cultures from the dejecta or the vomit or intestinal contents of cholera cases by means of the well-known Koch method of flesh-peptone-gelatine plate cultures, I inoculated flesh-peptone-agar tubes with this material, sometimes transplanting from tube to tube at intervals varying from a fortnight to a month or longer. Some of the agar-agar tubes of pure cultures of the comma bacillus which I took with me to Berlin at the time mentioned were the original inoculations from pure cultures in flesh-peptone-gelatine tubes obtained directly from the above-named plate cultures. Through the courtesy of Dr. Koch I was kindly furnished the necessary facilities for inoculation experiments upon guinea-pigs in the Royal Hygienic Institute of Berlin upon my arrival there. I conducted a number of different series of inoculations of guinea-pigs, using for that purpose the above material, which I myself had personally obtained, as also some cultures much older kindly furnished by Dr. Koch. These latter cultures were descended through numerous reinoculations of agar tubes from cholera material obtained from Toulon and Naples in 1884, as also cultures descended in the same way from material obtained at Valencia in 1885 by Raptchewski, the commissioner appointed by the Government of Russia to investigate cholera in Spain. These latter cultures had been presented to Dr. Koch by the Russian commissioner at the time of his sojourn in Berlin on his way homeward. Besides these inoculations made with the comma bacillus of Koch I also performed others upon similar animals with cultures of the Deneke or cheese bacillus and cultures of the Finkler-Prior bacillus, obtained in Berlin.

These inoculation experiments were performed after the well-known feeding method of Koch; that is to say, an alkaline solution varying in strength in proportion to the weight of

the animal was first introduced into the stomach by means of a stomach-tube for the purpose of neutralizing or rendering alkaline the reaction of the fluids contained in that organ. A few minutes after this a certain quantity of bouillon culture freshly made from the various cultures tubes in my possession was introduced in like manner into the stomach of the animal under operation. Subsequent to this an injection of a small quantity of the tincture of opium was made into the peritoneal cavity by means of a sterilized hypodermic syringe (Koch's), care being taken as much as possible to avoid wounding the intestine. The animals thus treated soon became decidedly narcotized, but recovered from the narcotic effects of the opium in a few hours and seemed to be apparently unharmed by the various operations performed upon them. On the next day, however, they showed signs of decided illness, such as prostration, coldness, and blueness of the nose and extremities, standing of the hair, etc. It was noticed, however, that there was invariably a difference in the rapidity of the effect of the injection between those pigs fed with the material which I myself had obtained in southern Europe and those fed with material which had been furnished me, as above mentioned, by Dr. Koch. The time of death was usually several hours shorter in the former case than in the latter, an indication that the material more recently obtained from the human cases of cholera possessed somewhat more virulent qualities than did that of the much older date. Nevertheless, in every case the feeding after the manner above described was sooner or later followed by the death of the animal.

Autopsies were made, under the most thorough aseptic precautions, as soon as possible after death of the animal. It should be stated before proceeding further that in none of these animals was diarrhoea or vomiting observed. The post-mortem examination invariably revealed a state of affairs indential with that described by Koch.

Immediately upon opening the animal the intestine was opened and a plate culture in flesh-peptone gelatine was made, after the usual method, from a small portion of the intestinal contents picked up by the point of a sterilized platinum needle. Similar attempts at culture were made from the heart blood and other fluids and from tissues of various organs of the body, including the spleen, liver, kidneys, the lungs. In a few instances colonies of the comma bacillus of Koch developed in the plate cultures made from the lungs. In one instance colonies of this bacillus were also found growing in plate cultures made from the pulp of the spleen. In this case also colonies of the comma bacillus of Koch were found in the plate cultures made from the lungs. From none of the other organs or fluids of the body was I able to obtain cultures of the comma bacillus.

Smear preparations upon thin cover-glasses were also made in every case immediately after the cultures had been made, and they embraced specimens of intestinal contents, heart blood, scrapings of the abdominal and pleural cavities, scrapings from the cut surface of the lungs, the liver, the spleen, the kidneys. In no case was I able, after staining and examining these cover-glass preparations under the microscope, to observe the presence of any curved bacilli, except in those specimens obtained from the intestinal contents. The latter constantly showed the presence of numerous curved bacilli intermingled more or less largely in most cases with other species of bacteria. Cover-glass preparations from the kidney, spleen, and heart blood were always free from visible bacteria. A few preparations of scrapings from the liver and the lungs showed the presence of a small number of various bacteria, none, however, presenting a curved form. Small pieces of the intestinal wall of the lower portion of the ileum, of the kidney, of the spleen, of the liver, and sometimes of the lungs, were clipped out and immediately placed in small vials containing absolute alcohol. These gross specimens were permanently sealed for transportation to America to be examined there by means of sections at my leisure.

The plate cultures above mentioned were set aside, covered from the air, in a moist chamber, and kept at the temperature of the surrounding air (these experiments were performed during the month of May, in 1886). In 24 hours those plates representing the material inoculated from the intestines were found to be swarming with small colonies of the comma bacillus of Koch, very few colonies of other bacteria existing among them. Within 36 to 48



hours development had so far advanced that the colonies of the comma bacillus presented clearly the well-known distinguishing characteristics of that microbe when cultivated in flesh-peptone-gelatine plates, and the examination of numbers of them showed these colonies to consist exclusively of curved bacilli. From one or more characteristic colonies, pure cultures in flesh-peptone-gelatine tubes and in flesh-peptone-agar tubes were made. Those cultures in the gelatine tubes within the space of 24 hours began to assume the characteristic appearance of puncture colonies of the comma bacillus of Koch. Furthermore, potato cultures were frequently also made from characteristic colonies in the gelatine plates.

I wish to call attention here to a notable fact which was in harmony with what has already been stated regarding the difference in virulence between my own material and that furnished by Koch. Not only in gelatine plate cultures made directly from this material, but also in similar plates obtained from the intestinal contents of animals which had been killed by the respective cultures, there was a marked difference in the rapidity of development of colonies derived from these respective materials. In every case the development was nearly twice as rapid in the case of cultures from my own more freshly obtained material as in that of the much older material furnished by Koch.

It may be interesting to mention also a marked difference in this respect between the gelatine plate cultures from the spleen and lungs of the case mentioned above, where comma bacilli were found to be present in the spleen and lungs of one guinea-pig. These two plate cultures were made at the same time, in the same manner, and with the same culture medium, and were subsequently kept under identical conditions of moisture and temperature; yet it was found that the comma bacillus colonies in the plate from the spleen were far more tardy in developing than were those in the plate from the lungs—at the end of 48 hours the colonies of the latter plate were twice as large as those of the former. To what this difference of biological activity may be ascribed I am unable to state, but merely mention the observation as a matter of interest.

This observation of the presence of comma bacilli in the spleen and in the lungs of the guinea-pig fed with cultures of this organism is not in entire accord with the observations of Dr. Koch, but is confirmatory of those few observers who claim to have found the comma bacillus of Koch in the tissues of the body of the experimental animal outside of the intestinal tract. The explanation advanced by one of Dr. Koch's assistants at the time concerning the finding of the comma bacilli in the lungs, seems to be quite plausible in accounting for the presence of this microbe in that organ; that is, the possibility of the microbes having reached the larynx and trachea either at the time of the operation or by regurgitation from the stomach after the animal had become moribund. But it is impossible that the comma bacilli could have reached the spleen in any other manner than through the blood current. It must be admitted, however, in this connection that in this animal cultures from the kidneys and from the heart blood remained sterile; no comma bacilli colonies developing therefrom.

I referred above to a series of similar experiments with pure cultures of the Deneke, or cheese bacillus, and of the Finkler-Prior bacillus. The results of these experiments proved each of these organisms to be possessed of a certain degree of pathogenic power, each of these varieties of curved bacilli being fatal to the animal in a certain number of cases; but they were far less virulent in their pathogenic power than were the cultures of the comma bacillus of Koch used in these experiments, several of the animals fed having survived. That the cause of death in these animals was due to the pure culture fed to them, and not to the accidental introduction of the comma bacillus of Koch, which was being experimented with at the same time, is shown by the fact that no colonies of the Koch bacillus developed in the various plate cultures made from the material obtained in the usual way from these animals post mortem.

After leaving Berlin in the early part of May, 1886, I proceeded to India for the purpose of continuing in that country my investigations upon cholera. In consequence of illness immediately after my arrival in Bombay, in the early part of June, 1886, which continued for three weeks, I was unable to pursue any investigations there, but immediately upon my recov-

ery proceeded to Calcutta, where every facility for pursuing investigations was furnished through the politeness of his excellency, the Viceroy, and the kindness of the president of the medical college of Calcutta, and of the medical officers attached to that institution. My investigations in that city were made during the months of July and August, under a very high temperature, with the atmosphere saturated with moisture, and more than usually loaded with various species of fungi and other germs. I found it impossible to use the gelatine plate or tube methods for the purpose of isolation and differentiation of bacteria, the difficulties of obtaining the comma bacillus of Koch being thereby enhanced. I was under the necessity of resorting to plate cultures with flesh-peptone-agar for the purpose of isolating the bacteria which I might find.

I made a number of examinations of the dejecta, vomit, and intestinal contents from cases of cholera by these means, and I succeeded in finding the comma bacillus of Koch in each of them. I could not be absolutely sure of this, however, until I had returned home with the pure cultures of curved bacilli which I there obtained and had subjected them to the usual biological test of culture in flesh-peptone-gelatine media. All of the pure cultures of curved bacilli, which I had isolated by means of the flesh-peptone-agar plates above mentioned from cholera cases subsequently proved to be genuine comma bacilli of Koch. Besides, the cholera material obtained in this manner, I made numerous examinations in the city of Calcutta of water from filthy ditches into which choleraic dejecta had probably been cast from neighboring native huts in which cases of cholera had recently occurred; as also of stagnant water obtained personally from one or two tanks around which were native huts in which cholera at that time was prevailing. From these sources I obtained numerous different species of bacteria, one or two of which consisted of curved bacilli, but in subjecting the latter to the flesh-peptone-gelatine test on my return to America, they proved to be morphologically different from the comma bacillus of Koch. Among the various bacteria thus obtained from this water I found a merismopædium which rendered the gelatine fluid and whose plate colonies in this medium presented an aspect very closely resembling that of the comma bacillus of Koch. This same merismopædium in pure culture in the gelatine tube after puncture inoculation again presented strong similarity of growth to that of the comma bacillus of Koch. The colony was funnel-shaped, and at the top of the funnel there was an apparent bubble of air, as in gelatine tube cultures of the cholera bacillus.

I have already stated that I had succeeded in finding the comma bacillus of Koch in the dejecta, vomit, and intestinal contents of patients suffering from Asiatic cholera at the New York quarantine station in the fall of 1887. Besides, the cultures of the comma bacillus of Koch from the sources already enumerated, I obtained cholera cultures from the Army Medical Museum, at Washington, which had proceeded from the Hygienic Institute at Berlin, as also cholera cultures from the bacteriological laboratory of the Johns Hopkins University at Baltimore, which had likewise proceeded from the same source.

After returning to America I conducted a large series of inoculation experiments upon guinea-pigs, as well as numerous culture experiments, for the purpose of examining more thoroughly than I had previously done, the morphological, biological, and pathological qualities of the various specimens of the Koch comma bacillus obtained from the various sources already mentioned. The results of these observations were only confirmatory of those already related, and it is not necessary, therefore, to enter into details concerning them. I might state, however, in this connection, that the curved bacillus which I obtained from the well-water in the town of Belmonte, in Sicily, already referred to, possessed no pathogenic power upon the guinea-pig.

Reference has been made to loss of virulence of cultures of the comma bacillus of Koch. I found by my experiments at Berlin that my own comma bacilli cultures, more freshly obtained from cholera cases and never exposed to the severe cold of a northern winter, possessed much more virulence and corresponding vital activity than did those furnished me by Koch, the latter having been derived from cholera patients much longer ago. It will be remembered that, after performing those experiments in Berlin during May of 1886, I obtained fresh



cholera material again during July and August of the same year in Calcutta. I therefore had in my possession the following cultures of comma bacilli of Koch: Cultures derived from the cholera epidemic at Toulon and Naples of 1884, which had passed through two winters in Berlin; cultures derived from the cholera epidemic in the summer of 1885, at Valencia, in Spain, which had passed through one winter in Berlin; cultures derived from the cholera epidemic in the autumn of 1885, in Palermo, which had not been exposed to the cold of winter in a northern latitude; cultures derived from an epidemic of cholera in southern Spain in February and March of 1886, which therefore had not been exposed to the cold of winter; cultures derived from cholera cases occurring in the city of Calcutta, during July and August of 1886, and which also had not passed through a winter.

Bad health for several months after my return to America made it impossible for me to do more with these various cultures until the spring of 1887. I then made new inoculations from time to time from agar-tube to agar-tube for the purpose of keeping them alive. They all therefore, passed through that winter in Philadelphia, and also gained that additional age. When I again resumed experimentation, including inoculations upon the guinea-pig, in the spring of 1887, besides the replantations of cultures, I had in my possession some original peptone-agar-tubes which I had inoculated with cholera microbes in Palermo in the fall of 1885, in the south of Spain in the spring of 1886, and in Calcutta in the summer of 1886. I found all of these alive except the original agar-tubes inoculated in Palermo.

But these various cultures showed marked variations in vitality and pathogenic power. Those obtained from Koch, derived from the cholera epidemics at Toulon and Naples of 1884, had completely lost their pathogenic power upon the guinea-pig. Those obtained from Koch, derived from the epidemic in Valencia of 1885, possessed but little pathogenic power upon the guinea-pig, only a small proportion of the animals experimented upon dying. Of my own cultures, those derived from the epidemic in Palermo of the fall of 1885, had lost considerable of their pathogenic power upon the guinea-pig—nearly one-half of the animals survived—all, however, were sickened (the original agar-tubes of this source being dead were not used); those derived from the epidemic in southern Spain of the spring of 1886, killed all the pigs fed with them, but required a longer time to produce death than did the cultures obtained from Calcutta; those cultures derived from cholera cases in Calcutta, in the summer of 1886, were invariably fatal to the guinea-pig, and killed in a shorter time than did the cultures last mentioned. It should be remarked here, concerning the results of these inoculations, that the statements apply only to feeding experiments with cultures which had been transplanted from time to time. In my experience cultures which had been systematically transplanted at shorter intervals, as a rule possessed more pathogenic power than those transplanted at longer intervals. Furthermore, I usually found that, where gelatine media had been used instead of agar—as it was sometimes when opportunity offered—in the transplantations, this series was somewhat more virulent than the agar series.

Besides the loss of pathogenic power above noted, there was also a decrease of vitality more or less proportional. As a rule, the rapidity of development of cultures was slower in the older than in the more recently derived cultures.

Another phenomenon of some importance I had frequent opportunity to observe during my experiments in 1887, that is, the longer the derivation of the culture from the original cholera material the greater the tendency to deviation of biological characteristics from those which, with singular regularity, distinguish the gelatine cultures of the comma bacillus of Koch. After the loss of pathogenic power, a period arrives when the colonies of this microbe are no longer capable of rapidly rendering the gelatine fluid. Then, neither the plate colonies nor the tube puncture colonies exhibit their distinguishing characteristics. These remarks apply also to cultures of the Finkler-Prior spirillum and to those of the Deneke or cheese spirillum. There occurs a period in the course of transplanting for a long time the Finkler microbe from gelatine tube to gelatine tube when the growth is no longer quite characteristic. Photos. Nos. 29, 30, 31, represent the appearance of gelatine-tube colonies of this spirillum at such a period; whilst the upper portion of the growth is natural enough, the spread laterally of the

growth along the track of the inoculation puncture is abnormally limited. In fact the liquefaction of the gelatine both at the surface and in the depth of the puncture, especially in the latter, proceeds with great slowness.

I wish, while speaking of my experiments performed in 1887, also to relate my experience concerning the production of immunity in the guinea-pig against the effects of virulent cultures of the comma bacillus of Koch. I learned while in Darjeling that D. D. Cunningham had repeated the experiments of Ferran concerning this matter, and that, as a result of his hypodermic injections into the guinea-pig of less than mortal doses of virulent cultures of the comma bacillus of Koch, he was obliged to admit that such injection appeared to confer an artificial immunity against the effects of larger doses which were invariably fatal when injected into guinea-pigs which had not been previously inoculated and afterwards recovered.

I have performed a similar series of experiments both with the older and with the fresher cultures which were in my possession. My experience is not altogether conclusive to my mind. I had difficulty in killing by large hypodermic injections of even the most virulent cultures in my possession—those from Calcutta—which had proved to be surely fatal when introduced into the neutralized stomach after the method of Koch. Those pigs which survived these hypodermic inoculations were inoculated a second time under the skin and as a rule with one-third larger doses. A small proportion of these died; the large majority did not. The survivors of this second injection were divided into two lots: (*a*) this lot were fed in the manner above described, with my most virulent culture, and all succumbed without showing any indication either by increased period of incubation, lengthened period of illness, or lessened intensity of symptoms; (*b*) this lot again received hypodermically an increased amount of virulent culture, and one died, the other five survived, most of them showing no signs of illness. I can not look upon these results as demonstrating conclusively either that there was or was not any immunity produced by the hypodermic inoculations. I do not regard the fatal effects of the feeding experiments in series *a* as proof of the negative, and for the following reasons: It is an established fact that the mortality among herds in localities affected by this disease is lowered about 90 per cent. after *hypodermic inoculations* of the anthrax virus prepared after the method of Pasteur; and it is a fact also well established that the same cattle which have an immunity within 10 per cent. of being absolute, as far as natural infection is concerned, can be made to acquire the fatal disease by *feeding* them with relatively enormous quantities of the spores of the anthrax bacilli. Even if my inoculated guinea-pigs had absolutely resisted the second and third hypodermic injections, thus proving that they had acquired a positive immunity, I would not be justified, in the light of the above cited results concerning anthrax, in concluding that no practical immunity had been conferred by the *inoculation* because *feeding* had subsequently killed them. I should remark before leaving this subject that *living* cultures were used in these experiments on immunity. I much regret that at the time of performing these latter experiments I was unacquainted with any method of increasing the virulence of comma bacilli cultures, such as those recently announced by Löwenthal and Gamalëia.

I am forced to state, therefore, as a result of my personal observations, that I must confirm those of Koch concerning the pathogenic power which he claims for his comma bacillus over the guinea-pig.

I am constrained to admit that, as far as my own inoculation experiments upon the lower animals are concerned, the proof is not absolutely conclusive that the comma bacillus of Koch is the specific cause of Asiatic cholera. But these and similar results of experimentation upon animals taken together with the recent publications by Hueppe, Löwenthal, and Gamalëia concerning the possibility of restoring to the comma bacillus of Koch the virulent power which it rapidly loses in artificial culture, and of rendering it exceedingly virulent for certain of the lower animals which, because of rapid attenuation, it has been previously unable to harm; and taken in conjunction with the experiments of Ferran upon the guinea-pig, and those confirmatory thereof made upon the same animal by D. D. Cunningham, of Calcutta; and considered in relation with the evidence presented by the history of the anticholeraic



inoculations in Spain by Ferran of a prophylactic power against cholera in man apparently possessed by fresh cultures of the comma bacillus of Koch, must in my opinion be regarded as falling but little short of demonstration of an etiological relation of the comma bacillus of Koch with Asiatic cholera.

## SECTION 2.

### PLASMODIUM MALARIE A MEANS OF DIFFERENTIAL DIAGNOSIS FROM CHOLERA.

#### DISCOVERY OF THE PLASMODIUM MALARIE IN THE BLOOD OF THOSE SUFFERING FROM MALARIAL DISEASES.

The discovery of Laveran concerning the presence in the blood of the human being suffering from malaria of a peculiar parasite, since amply confirmed by competent observers in Rome, Baltimore, Philadelphia, and Bombay, is of sufficient importance to warrant some reference to it in a report of microscopic observations, which are related more or less closely to cholera asiatica. It is the experience of Laveran, Marchiafava and Celli, Tommasi-Crudeli, Councillmann, Osler, and Vandyke Carter that the so-called *plasmodium malariae* when found in the red blood corpuscles or blood plasma of a patient under observation furnishes sufficient warrant for the differential diagnosis of malaria as against any of the various diseases for which, on account of similarity of symptoms, it might be mistaken. This statement explains why I have determined to introduce in this report on cholera some reference to the *plasmodium malariae* and give a place among the illustrations to a reproduction of an engraving representing very faithfully the microscopic appearances of this parasite. Those who wish more particular information concerning the observations of these authors will do well to consult their original and highly important papers relating to the subject.

While in Rome in 1885, through the courtesy of Professors Marchiafava and Crudeli I had the opportunity of seeing this parasite of the human blood in the case of a patient suffering slightly from malaria. I have also assisted at some of the observations of the plasmodium malariae reported by Professor Osler, of Philadelphia, in his important communication relating thereto, and I have witnessed some demonstrations made by Professor Councillmann, of Baltimore, illustrative of the observations which he has published.

Having seen the organism numbers of times on the occasions above mentioned, and knowing the skillfulness and reliability of those observers, I do not hesitate to accept, at least until some strong adverse testimony shall be forthcoming, the presence of the plasmodium malariae in the blood of a patient under observation as sure indication that the disease is some form of malarial fever. I can conceive of suspicious cases, particularly among those at the commencement of an epidemic, before opinion is well settled concerning the nature of the disease, where it is all important to decide whether we have to deal with an attack of cholera infectiosa or of pernicious intermittent fever. An examination of the blood is a matter of only a few minutes. If it result in finding the plasmodium malariae the diagnosis is at once determined. For the culture test necessary to determine with certainty at least 24 hours are required, usually 36 to 48 hours.

Photos Nos. 34, 35, 36 represent fairly the appearance of the plasmodium malariae in two of the forms in which it is encountered.

## NOTE ON SOME ASPECTS AND RELATIONS OF THE BLOOD ORGANISMS IN AGUE.

By H. VANDYKE CARTER, M. D., of Bombay.\*

Respecting abnormal aspects of the blood in fevers termed "malarial," no fresh information had been acquired of late, nor had the bacilliary structures, described to me at Rome in 1880-'81 by Professors T. Crudeli and Marchiafava, been witnessed subsequently at Bombay, and hence this subject (others intervening) had remained in abeyance until the present year, when the striking confirmation of Dr. Laveran's researches by Professor Osler, published in the British Medical Journal of 12th March, 1887, compelled, as it were, renewed attention. In July last I therefore regularly examined the blood of a man affected with quartan ague, and, detecting in it at fever periods many pigmental spherules, I next found in another patient the equally characteristic crescentic bodies, after which further inquiry was continued until October, with the results now noted.†

It has thus been already ascertained that in western India the so-termed "hæmatozoa of malaria" are readily to be discerned, and, as this datum will doubtless apply to India generally, the conclusions arrived at here as well as elsewhere can be tested without delay.

Dr. A. Laveran's original work, the "*Traité des fièvres palustres*, Paris, 1884," contains a full account of his "microbe du paludisme" in its ordinary free forms, all of which I have seen; and subsequently to those Algerian discoveries of 1880-'81 Dr. Marchiafava and several observers in Italy have added to the list of "malaria organisms" other minuter forms sessile within the red blood disks, which Dr. Osler in America also fully recognizes, and which to a certain extent have been verified here.

While so far in accord, the results newly acquired at Bombay yet differ in some respects, and will therefore be given in detail, the kind and source of data‡ being first stated, next the organisms described, and lastly some of their relationships discussed. After relating the observations of his cases in detail the author passes to the following summary remarks: (Illustration No. 16 well represents these parasitic bodies of the blood in Malaria. For detailed description consult the following section of this chapter.)

Summarizing the whole data, I consider there is proof enough that the genuine "ague-state"—the "malaria process" in older terms, and in new the "malaria infection"—is pathologically distinguished by a visible living blood contamination (*a*) having hæmatozoic rather than hæmatophytal affinities (*b*), and displaying a relationship to clinical symptoms which, if often less precise than obtains with pathogenic bacterial infections, may none the less be real (*c*). Further, it has been shown that in arresting malarial pyrexia the drug quinine does not with equal promptitude annihilate the blood parasite (*d*), this datum also indicating a probable different relationship of phenomena in the monadic as compared with bacteric infection. That the hæmatozoa undoubtedly present in ague holds a close, if not causal, relation to that disease may be inferred from first their constituting an adequate pathogenic influence and next their exclusive limitation to this one morbid affection; nor need such influence be annulled by seemingly conflicting evidence regarding the details of association. According to my observations, the visible blood contamination may be more constant and uniform than concurrent pyrexial phenomena, and hence the inference that it is fundamental, whilst "fever" is rather a contingent event. Certainly not all fever in malarious subjects is necessarily monad-pyrexia, and by experience I have been led to recognize at least three forms of such "fever"—namely, first, the genuine specific form with its positive blood aspects; next and oftener in old cases, the consecutive residual or quasi-reactive form with its negative blood state, which may have simulated the genuine type in a clinical sense; and, lastly, the pyrexia pertaining to a superadded infection, which for a time supersedes the monadic—as, for example, was demonstrated for enteric fever by Dr. Laveran (*l. c.*, p. 378). As to nature and causation,

\*Scientific Memoirs, by Medical Officers of the Army of India, 1887.

†During November some further data were acquired, which are alluded to in a Note at the end.

‡The data comprise examinations of 73 cases of malarious fevers and 27 cases of non-malarious fevers.



I would add, that present results serve to explain the paroxysmal and periodic character of paludal fever, through the corresponding definite duration and reproduction of a living contagium. That such pathogenic agent should be zoöic rather than phytal is a datum of etiological import, because infusorial life is known to prevail under different and more restricted condition than the bacterial, and hereby a clue may be gained as to the sources of ague-infection. The foreign and nondescript term of "malaria" adopted in Britain since 1827, may soon have to be abandoned if not in favor of the prior indigenous name of "marsh" poison, at least of a designation referring to definite conditions of soil, moisture, and water supply. Not long since the late sagacious professor of military medicine at Netley wrote respecting the new researches in Europe as follows: "Should future investigations by independent observers in other malarious regions confirm these conclusions, it would be difficult to overrate their importance (Maclean in Quaine's Dictionary, Part II, p. 914)," and now it may be seen how far as regards India such confirmation has been realized.

### SECTION 3.

#### ILLUSTRATIONS WITH EXPLANATORY NOTES.

##### DESCRIPTION OF ILLUSTRATION NO. 16.—THE BLOOD ORGANISMS SEEN IN AGUE.

[Magnifying power, 800-1,000 diameters.]

##### SERIES A.—INTRA-DISK FORMS.

FIG. 1. Two red blood disks showing a minute pale body which at first seemed to be pedunculated (*upper disk*) and then disengaged, when it began to display distinct amæboid movements, attended with various marked changes of form (represented at one instant in the *lower disk*) and some increase of dimensions at the end of an hour's watching; no further alterations. No pigmentation here, though present in other disks, near which were, apparently undergoing transitions to free pigmented organisms, both spherules and crescents. Aspect not uncommon. From case No. 7, just after admission and during decline of fever (axillary temperature, 100° F.), under the influence of quinine (20 grains).

FIG. 2. Two red corpuscles from the same patient, on the following day (axillary temperature, 99.4° F.); quinine continued. The plasmic body in the *upper disk* contains a dark granule, active, and, with its containing space, changing form and site. The *lower disk* presents four pale specks on its surface; similar plasmic specks were seen in the free state around: a notched appearance of the edge of the disk not rare is also shown.

FIG. 3. A series of four blood disks from the same patient, selected as indicating one mode in which pigmented *spherules* may be formed, namely, by the gradual growth of a pigmented plasmic body, first attached near border of disk, and in the course of a few hours invading its whole area; blanching and some contraction in diameter of the disk consentaneously occurring. Free dotted, plasmic specks in the fluid medium around. Date—the second day after arrest of fever by quinine, with continued exhibition of the drug; the spleen enlarged and tender. For similar disk aspects see also below series B, *b*, spherules bare, Fig. 6\*, from another patient.

FIG. 4. A series of 4 blood disks, from the same patient and at similar date; indicating one way at least in which pigmented *crescents* may be formed, namely, by attachment and growth of a pigmented body, with consentaneous collection around it of the colored plasma of the disk, whereby at the opposite pole of the disk the stroma becomes blanched and finally forms the fringe of the crescent. \*Is a side view, showing the turgidity and rather lessened diameter of the implicated blood corpuscle; see also series B, *a*, crescents, Figure 3, below. Crescentic organisms being persistent, continue to grow in dimensions after their formation as above.

FIG. 5. A red blood disk, with pale, active *coccus*-like bodies on its surface, which on watching for some hours; did not show further development; the corpuscle itself though not pallid seemed a little shrunken and changed its outline. Within the disk area the cocci became dispersed or variously aggregated after the manner of black pigment granules in spherules and crescents. In the liquid medium near free cocci were present, not arranged in cluster or chain. From case 6 on fifth day after arrest of fever by quinine and continued exhibition of the drug: axillary temperature, 98.2° F.; aspect rare. Free organisms were present in the blood.

FIG. 6. A red blood disk which showed on watching active *amæboid* movements, such as here delineated at one instant, and pertaining apparently to a pale, finely granular, plasmic material or body within the disk area and clearly differentiated from the colored portion of the corpuscle. Movements varied and persistent for an hour at least without further change; the disk was turned about, but not displaced by them. Aspect occasional only. Date the ninth day after arrest of fever by quinine (drug continued; t., 98.6° F.). Flagellate organisms seen the day before; no free organisms co-present, and none visible for remaining 19 days of patient's convalescence in hospital.

FIG. 7. Two red blood corpuscles, introduced as samples of aspects often visible in healthy blood, as well as the feverish, and evidently attendant on altering physical conditions alone. The separation of colored and colorless portions of the disk, is as distinct as that following parasitism of the corpuscles, and within slow movements occur; but pigment formation is absent and all signs of serial change around.

#### SERIES B.—FREE FORMS.

##### A.—THE CRESCENTIC.

FIG. 1. Parasitic organisms -seen in fresh blood, towards the close of a febrile paroxysm, quotidian ague—Case No. 2, m. t., 103° F.; remarkably little distress shown, and the spleen not projecting and not tender. At *a. a.* normal red corpuscles; *b. a.* leucocyte; *c. c.* the pigmented *crescents*; at \* changes of aspect in a pigment spot at successive 5-minute intervals, and at \*\* other variations in aspect seen after the sweating stage; no quinine.

FIG. 2. *Crescents* seemingly held by infolded red corpuscles; aspect not very common. From the same patient, in subsequent apyretic intervals.

FIG. 3. The *three upper* crescentic bodies are from a specimen (fever stage) of fresh blood, after slight evaporation of the serum, so that the organisms, no longer floating quite upright, are seen partly from their side and their pendent membrane thereby rendered more clearly visible. The *four lower* bodies are from stained and mounted specimens (same patient); at \* an unchanged blood disks; and close by a crescent entire and still inclosed, and in diameter rather less than the disk. Non-febrile stage, and tinted with methyl-violet. The *three lowest* bodies are from febrile specimens stained with fuchsine and violet; they show the membrane either complete or partly shrunken, the organisms often seeming to shrink a little during the process of preparation.

FIG. 4. Some *varieties* in the shapes of fresh crescents, indicating an approach to the spherical form.

FIG. 5. Threestained *crescents*, showing irregular distribution of stain and of pigment, after the action of water and of acetic acid. At \* apparently an evacuated crescent, with the pigmented spheroid body, which had thence become extruded; fresh specimen non-febrile; and numerous free organisms also present, including the flagellate.

##### B.—THE SPHERICAL. BARE.

FIG. 6. Pigmented *spherules* seen in fresh blood during the stage of "rigor" quartan ague.—Case No. 1., *a. a.* Unaltered red disks; *b.* a spheroidal body, at successive periods of 20 minutes watched; at \* below, a pigmented body with large nucleus, and a red corpuscle with spheroid apposed observed in the same specimen; see also series A, Figure 3, above.



FIG. 7. A group of four *spherules*, from the same case, and taken at estimated, "acme" of the febrile paroxysm (t., 103.4° F.). Below, three other spherules taken four hours after cessation (spontaneous) of pyrexia. To show amœboid and varying aspect of the spheres and of their pigment contents.

FIG. 8. Other *spheroids* taken on day of expected relapse, before the setting in of "rigors"; magnified 1,000 diameters. Shows a tendency to partition of spherules and to assumption of crescent shape?

FIG. 9. Other *spheroids* taken at "hot" stage of a paroxysm (t., 106° F.), showing an apparent division or disruption of some bodies, with dispersion of the dotted granules (? germs) thence resulting. Case 1, quinine not given. At \* a similar aspect of spontaneous partition, with separation of the pigment, noted in case No. 2, at non-febrile state (quinine administered).

FIG. 10. *Pigmented plasmoid particles* frequently seen in the free state, and seemingly indicative of one mode in which free spheroids may be formed afresh, namely, by direct growth of such freed particles.

#### FLAGELLATE ORGANISMS.

FIG. 11. A *flagellate* or *ciliated spherule*, as seen in fresh blood. Case No. 5, non-febrile and without quinine; the flagella were in very active lashing movement, the central body oscillating slightly, and its pigment contents also much agitated. Whilst being watched the organism was seized by a wandering, coarse-grained *amœba*, after a struggle becoming involved, and in the course of 20 minutes carried away, as indicated by *Figures a.* and *b.*, this phenomenon being so frequently witnessed as to appear not merely incidental.

FIG. 12. Another *flagellated body* from case No. 6, during convalescence on eighth day after arrest of fever, and the blood thenceforth free from visible contamination; quinine exhibited. Movements so active that the number of flagella could hardly be surely ascertained; amœbæ here, too, early made their appearance. At \* is another pigmented body belonging to a flagellated organism, introduced to show a striated arrangement assumed by the agitated pigment particles within during struggles against an invading and finally conquering amœba. At \* \* 3 liberated and free-moving *flagella*, somewhat resembling bacteric spirillar organisms they are distinctly knobbed midway or at end.

#### FORMS OF BLOOD CORPUSCLES AND MELANÆMIC GRANULES.

FIG. 13. A group of *red blood disks* agitated and distorted by a slender lashing filament, which had become detached from a neighboring flagellated body during its brief movements under scrutiny; the thrilling aspect amongst the corpuscles was very evanescent, and, being detected in two or three separate parts of the field, it seemed that more than 1 flagellum was liberated or else after detachment 1 had continued to travel. An appearance not very rare.

FIG. 14. A *phagocyte* containing in its interior 2 pigmented spheroids.

FIG. 15. *Melanæmia*. A group of pigmented structures seen together in the blood the day after "crisis" of paroxysmal fever—Case No. 6. At *a* an enormous nucleated cell (? splenic endothelium) loaded with pigment masses ("melanine", so-called), extra nuclear in site and opaque black in tint; many such cells were present; at *b* an ordinary smaller leucocyte, also common; at *c* spheroidal, cylindrical, and semi-lunar organisms (some red corpuscles also added), which were seen in proximity and likewise not infrequent.

#### ILLUSTRATION NO. 17.—PHOTOGRAPHIC REPRODUCTIONS OF PHOTO MICROGRAPHS.

The following illustrations are reproductions from photo-micrographic negatives made by the writer. These negatives have not been touched in any manner by the pencil of the artist, neither has the latter intervened in the process of reproduction. What is represented in these photo-micrographs has been accomplished solely by the process of light and chemistry, and

these illustrations may consequently be regarded as faithful representations of the morphology of the objects as they are seen, modified only by the imperfections in the present art of photomicrography and the mechanical methods of reproduction of the same in print by the process of photo-engraving.

Photo. No. 1 also represents a microscopical view of the *dejecta* from a case of *cholera* in the second stage, occurring in the city of Palermo during the epidemic of 1885, and shows among a large number of various species of bacteria a few curved bacilli (comma bacillus of Koch). Magnification, 1,200 diameters.

Photo. No. 2 represents the characteristic appearance of a *colony of comma bacilli* of Koch in a flesh-peptone-gelatine plate culture *from the intestinal contents* of a fatal case of *cholera*, in which the autopsy was made within an hour after death. Culture 48 hours old. Magnification, 50 diameters.

The dark nucleus presents the aspect of fine particles of broken glass. It has an irregular outline, as is seen in the photograph, and is surrounded by a narrow zone filled by clear fluid in which a few scattered particles consisting of comma bacilli have settled to the bottom.

Photo. No. 3 represents the characteristic appearance of another *similar colony*. Culture 48 hours old. Magnification, 50 diameters.

Photo. No. 4 represents the characteristic appearance of a flesh-peptone-gelatine plate culture 24 hours old of a *colony* of the curved *bacillus of Finkler* which he found in a case of so-called cholera nostras. Magnification, 50 diameters.

Photo. No. 5 represents the characteristic appearance in flesh-peptone-gelatine plate cultures 48 hours old of *colonies* of a *curved bacillus* morphologically identical with that of cholera, found in the water of a well in the town of *Belmonte*, in Sicily; where cholera was prevailing. This bacillus, however, does not liquefy gelatine. Magnification, 50 diameters.

Photo. No. 6 represents the characteristic appearance in flesh-peptone-gelatine plate cultures 48 hours old of an air *micrococcus* which does not liquefy gelatine. Its coarsely granular aspect resembles very closely that of the nucleus of a true cholera colony. Magnification, 50 diameters.

Photo. No. 7 represents the characteristic appearance in flesh-peptone-gelatine plate culture 72 hours old of another air *micrococcus* which liquefies gelatine. The dark nucleus which represents the colony presents an exceedingly irregular outline, the aspect of the colony is exceedingly granular, like that of broken glass. This colony is surrounded by a zone of liquefied gelatine. The general appearance of this colony in gelatine-plate culture is so near that of a colony of the comma bacillus of Koch that by this method alone it is impossible to distinguish between the two. Magnification, 50 diameters.

Photo. No. 8 represents a microscopical appearance of a *smear preparation* made from a broken-down beef-bouillon culture fluid which had been exposed to the air, kindly made for me in 1881 by my friend Prof. George A. Piersol, of the University of Pennsylvania. It shows *various species* of bacteria. Among others bacterium termo and a curved bacillus. Magnification, 800 diameters.

Photo. No. 9 represents the microscopical appearance of a *smear preparation* from a broken-down beef-bouillon culture exposed to the air in my laboratory, which my friend Dr. Piersol, above mentioned, kindly made for me in 1881. This fluid seemed to contain a pure culture of *large curved bacilli*. Magnification, 800 diameters.

Photo. No. 10 represents the microscopical appearance of a smear preparation of *comma bacilli of Koch*, presented to the writer in 1884 by Dr. Koch. This photograph was also kindly made for me by my friend Dr. Piersol in 1884. It shows characteristic forms of the comma bacilli described by Koch, including *spirilli*. Magnification, 1,000 diameters.

Photo. No. 11 represents the microscopical appearance of a *smear preparation* from a *pure culture* of the *comma bacillus* of Koch six days old. The photograph shows among the curved bacilli also the *spirilli* form of this microbe. In addition there is a small number of minute spherical bodies corresponding to the so-called *arthrospores* of Hueppe or *ögonia* of Ferrán. Magnification, 1,200 diameters.



Photo. No. 12 represents the microscopic appearance of a *smear preparation* from a *pure culture* of the *curved bacillus* found in the well water of *Belmonte*, Sicily, above mentioned. Magnification, 1,200 diameters.

Photo. No. 13 represents the microscopic appearance of a *pure culture* of the *curved bacillus* of *Finkler*, which he found in a fatal case of *cholera nostras* and believed at first to be identical with that of Asiatic cholera, but subsequently admitted its difference biologically from the latter. The photograph shows, besides numerous curved bacilli, a good example of *spirillar* form of this microbe. Magnification, 1,200 diameters.

Photo. No. 14 represents a *smear preparation* of a *pure culture* of the *Deneke* or *cheese bacillus*. Magnification, 1,200 diameters.

Photo. No. 15 represents the microscopic appearance of a *smear preparation* 6 days old from a *pure culture* of the *Deneke* or *cheese bacillus*. It will be observed that besides a number of more or less curved bacilli there are a few *spirilli* form of this microbe. Magnification, 1,000 diameters.

Photo. No. 16 represents the microscopic appearance of the *spirillar form* of the *comma bacillus* of *Koch*. Old culture in gelatine. Magnification, 1,500 diameters.

Photo. No. 17 represents the microscopical appearance of a *smear preparation* from a *pure culture* 8 days old of the *comma bacillus* of *Koch*. The whole field of the microscope is filled by an intertwining *mesh of spirilli*. There are scarcely any short bacilli visible. Magnification, 1,000 diameters.

Photo. No. 18 represents the microscopical appearance of *smear preparations* from a *pure culture* of the *comma bacillus* of *Koch* 6 days old. Besides a lot of *granular matter*, there are a few *exceedingly curved* bacilli visible. Magnification, 1,200 diameters.

Photo. No. 19 represents the microscopical appearance of a *pure culture* of the *comma bacillus* of *Koch* 10 days old. In the field of the microscope *exceedingly curved* bacilli are visible. One or two complete *circles* are seen. Some *short spirals* and a large number of *globules* of variable size. The latter correspond in form to the so-called *ögonia* of *Ferrán*. Magnification, 1,200 diameter.

Photo. No. 20 represents the microscopical appearance of a *smear preparation* from a *pure culture* of the *comma bacillus* of *Koch* 10 days old. There are visible numbers of *spherical bodies* corresponding to the *ögonia* of *Ferrán*. Most of these are isolated, some are attached to and in *continuity* with the *spirilli*. One or two short curved bacilli sprouting from them. Magnification, 1,200 diameters.

Photo. No. 21 is from a *negative* presented to the writer by *Dr. Jaime Ferrán*, of *Tortosa*. It represents the microscopic appearance of a *pure culture* of the *comma bacillus* of *Koch*, obtained by that investigator from a case of Asiatic cholera.

It shows besides a few isolated *curved bacilli* one or two *long spirilli* and a few *shorter spirilli*. The field also contains a number of *spherical bodies* of variable size, the so-called *ögonia* of *Ferrán*. Magnification, about 1,600 diameters.

Photo. No. 22 represents the microscopical appearance of a *smear preparation* from a *pure culture* of the *Miller bacillus* of the *mouth*. The micro-organisms strikingly resemble morphologically the *curved bacillus* of *Koch*, but Professor *Miller* in his report upon the same declares the non-identity of the two as shown by differences in culture. Magnification, 1,200 diameters.

Photo. No. 23 represents the microscopical appearance of a *smear preparation* made 8 years ago by the writer, found in the discharge of a *uterine ulcer*. Besides *nuclei* of *pus corpuscles* and *leucocytes* a few *curved bacilli* are seen. Magnification, 1,200 diameters.

Photo. No. 24 represents the microscopical appearance of a *smear preparation* made by the writer 8 years ago from scrapings from an *intestinal ulcer* in a case of *dysentery*. Among the mass of *débris* and *pus corpuscles*, besides other species of *bacteria*, a *curved bacillus* is seen. Magnification, 1,200 diameters.

Photo. No. 25 represents the microscopical appearance of a *smear preparation* from a scraping of the cut surface of the exudate filling the *lungs* of a patient dead of *croupous pneumonia*. Besides a number of *leucocytes* and *pus corpuscles* a small number of more or less *curved bacilli* are seen. Magnification, 1,200 diameters.

Photo. No. 26 represents the microscopical appearance of a *smear preparation* from the *pure culture* of a species of *micrococcus* which liquefies gelatine much after the manner of the comma bacillus of Koch. Magnification, 1,200 diameters.

Photo. No. 27 represents the microscopical appearance of a *smear preparation* from the *sputa* of a case of pulmonary *tuberculosis*. The usual appearance of the *tubercle bacilli* is well represented.

Photo. No. 28 represents the microscopical appearance of a *smear preparation* from a *pure culture* of the *bacillus typhosus*, obtained by inoculating sterilized culture medium with blood withdrawn from the spleen under aseptic precautions during life from a patient suffering with typhoid fever. The polar staining and the spindle form of the bacilli are well shown. Magnification, 1,200 diameters.

Photos. Nos. 29, 30, and 31. These are photographs, natural size, of tube cultures in flesh-peptone-gelatine 10 per cent., respectively, of the comma bacillus of Koch, the bacillus of cholera nostras or Finkler, and of the Deneke or cheese bacillus, at three ages of culture; each series of three being of the same age of culture, the upper series represents cultures 48 hours old, the middle series cultures 52 hours old, the lower series cultures 90 hours old.

Photo. No. 32 is a view natural size of the characteristic appearance of a 72-hour old tube culture in flesh-peptone-gelatine 10 per cent. of the comma bacillus of Koch (the surface of the solid gelatine was inclined). The appearance of an air-bubble at the top and the funnel shape of the culture are well shown.

Photo. No. 33 is a photographic reproduction of a series of six gelatine tube cultures of the comma-bacillus of Koch, that to the left 24 hours old, those to the right of it of regularly increasing age. (Copied from Gaffky's official report of the German Cholera Commission. Berlin, 1887.) Natural size.

Photo. Nos. 34 and 35 represent photographs of the same field of the microscope, at intervals of ten minutes, of a specimen of malarial blood. In No. 34 is seen a plasmodium in two red blood disks. One of these is contained in a blood disk very much larger than the average. In No. 35 this same plasmodium is photographed, but the surrounding blood corpuscle has lost its color and become nearly or quite invisible.

Photo. No. 36 represents the crescentic form of the plasmodium with a pigmented nucleus. Two crescents are visible in this field. The blood was obtained from a case of chronic malaria.

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ILLUSTRATION NO. 18.—B. ENGRAVINGS SHOWING THE MICROSCOPIC APPEARANCE OF CHOLERA AND OTHER BACTERIA.

[From careful drawings made by aid of the camera lucida.]

FIGS. 1, 2 represent bacterial contents of the ileum from a rapid case of human cholera, showing a few comma bacilli interspersed among a number of other species of microbes. Magnification, 800.

FIGS. 3, 4, 5 represent the morphological appearances and variations in size of various urpe cultures of the comma bacillus. Magnification, 1,000 diameters.

FIG. 6 represents comma bacilli from another culture, in which there is a tendency to the formation of spirilli shown. Magnification, 600 diameters.

FIG. 8 represents a preparation from the pure culture of the bacillus of Finkler and Prior, showing curved bacilli and spirilli. Magnification, 600 diameters.

FIG. 9 represents a preparation from a pure culture of the cheese bacillus of Deneke. Magnification, 600 diameters.

FIG. 10 represents an old culture, still pure, of the cheese bacillus of Deneke, where there is a great prevalence of jointed spirilli. Magnification, 600 diameters.

FIG. 11 represents the pure culture of the helio-bacillus of the stomach (Miller). Magnification, 1,000 diameters.

FIG. 7 represents spirilli and so-called *ögonia* of Ferrán in a pure culture of Asiatic cholera. Magnification, 800 diameters.



## ILLUSTRATION NO. 19.—C. ENGRAVINGS SHOWING THE APPEARANCE OF PLATE COLONIES.

[From drawing made by aid of the camera lucida.]

FIG. 1 represents the appearance of flesh-peptone-gelatine *plate colonies* 48 hours old of the comma bacillus of Koch. Magnification, 50 diameters.

FIG. 2 represents the appearance of flesh-peptone-gelatine *plate colonies* 36 hours old of the Deneke bacillus. Magnification, 50 diameters.

FIG. 3 represents the appearance of flesh-peptone-gelatine *plate colonies* 24 hours old of the Finkler-Prior bacillus. Magnification, 50 diameters.

FIG. 4 represents the appearance of flesh-peptone-gelatine *plate colonies* of a new (Belmonte well water) curved bacillus 48 hours whose morphology is identical with that of the comma bacillus of Koch; this bacillus does not, however, liquefy the gelatine. Magnification, 50 diameters.

## ILLUSTRATION No. 20.—P. ENGRAVINGS SHOWING NAKED EYE APPEARANCES OF TUBE CULTURES.

FIGS. 1, 2, 3 represent the appearance of tube cultures at various ages of the comma bacilli in flesh-peptone-gelatine; natural size.

FIGS. 4, 5, 6 represent the appearance of tube cultures of the Deneke or cheese bacillus at various ages in flesh-peptone-gelatine.

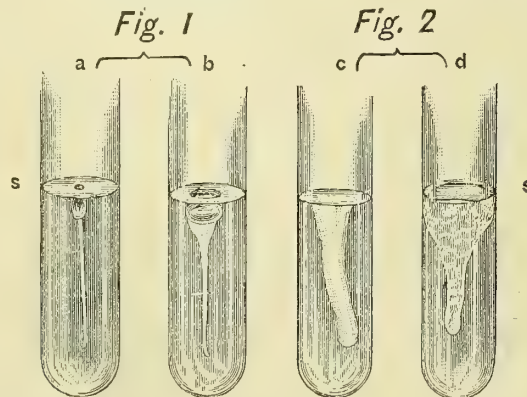
FIGS. 7, 8, 9 represent the appearance of tube cultures in flesh-peptone-gelatine of the curved bacillus of Finkler-Prior at various ages.

FIG. 10 represents the appearance in flesh-peptone-gelatine of tube cultures of a new curved bacillus which does not liquefy the gelatine, but in plate cultures presents colonies having distinctly worded concentric rings (Belmonte bacillus).

## ILLUSTRATION No. 21.—APPEARANCES OF GELATINE TUBE CULTURES OF THE COMMA BACILLUS OF KOCH AND THAT OF FINKLER-PRIOR COMPARED.

FIG. 1 represents two tube cultures in flesh-peptone-gelatine of the comma bacillus of Koch, at different ages; a, 24 hours old; b, 48 hours old.

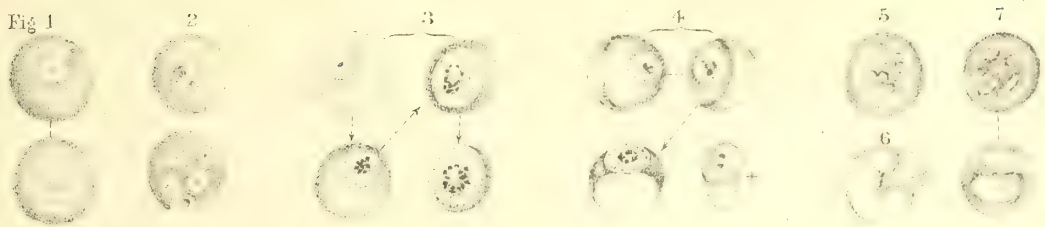
FIG. 2 represents two tube cultures in flesh-peptone-gelatine of the Finkler-Prior bacillus at the same ages, respectively, as tubes a and b of Fig. 1. (Both figures copied after Koch.)



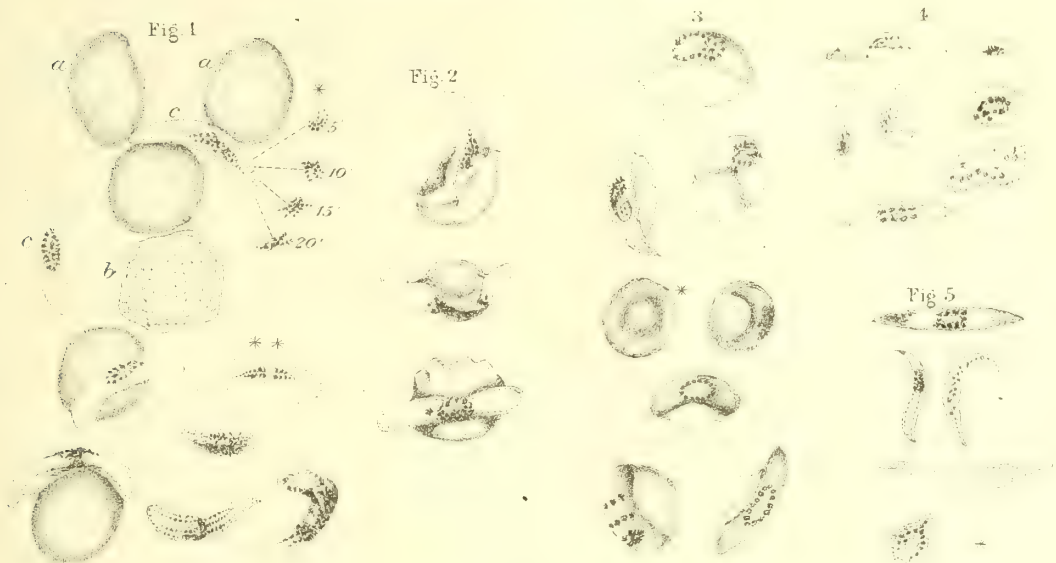
# ILLUSTRATION NO 16.

## BLOOD ORGANISMS OF AGUE

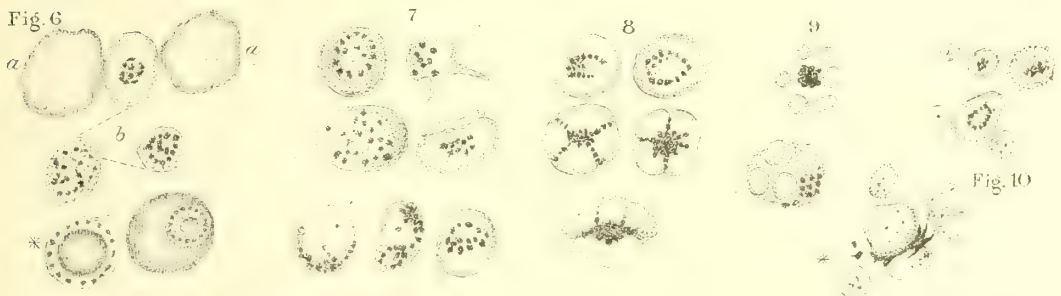
### A. INTRA-DISC FORMS AND ASPECTS



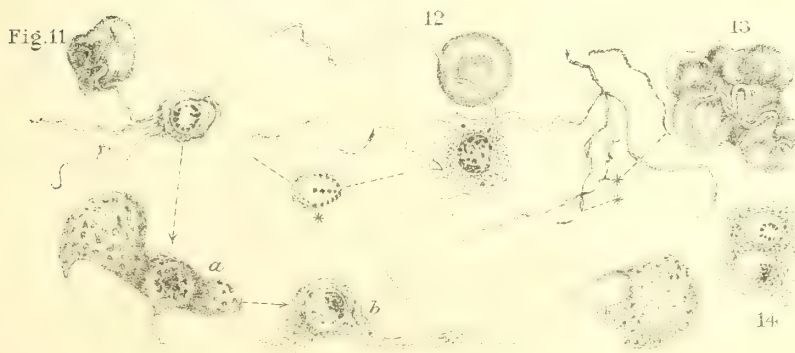
### B. FREE FORMS a. THE CRESCENTIC



### b. THE SPHEROIDAL BARE

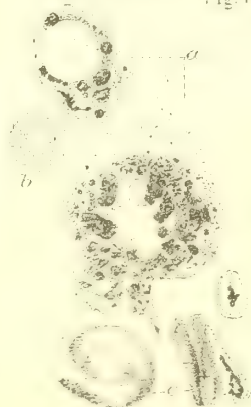


### FLAGELLATED ORGANISMS



### MELANAEMIA

Fig 15

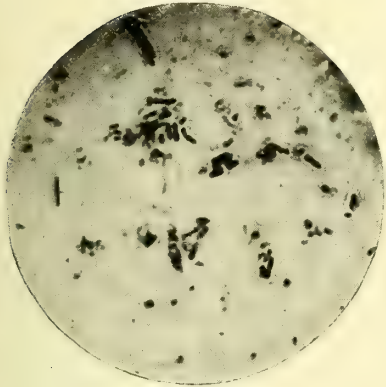






A.—ILLUSTRATION No. 17.—PHOTOGRAPHS.

PHOTOGRAPH No. 1.



Intestinal contents of cholera infectiosa.  $\times 1200$ .

PHOTOGRAPH No. 2.

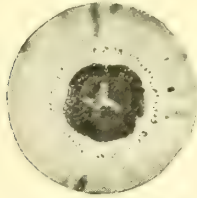


Plate colony of comma bacillus of Koch.  $\times 50$ .

PHOTOGRAPH No. 3.

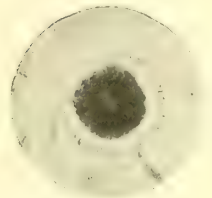


Plate colony of comma bacillus of Koch.  $\times 50$ .

PHOTOGRAPH No. 6.

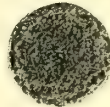


Plate colony of air micrococcus; does not fluidify gelatine.  $\times 50$ .

PHOTOGRAPH No. 4.



Plate colony of curved bacillus of Finkler-Prior.  $\times 50$ .

PHOTOGRAPH No. 5.

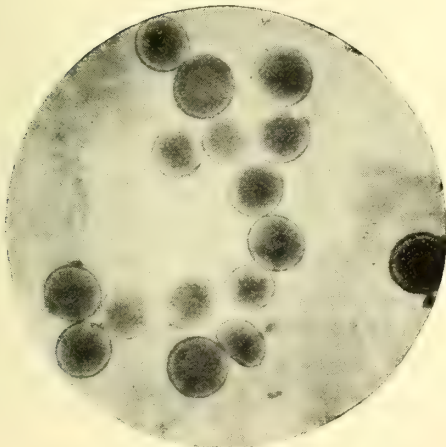


Plate colonies of Belmonte curved bacilli.  $\times 50$ .

PHOTOGRAPH No. 7.

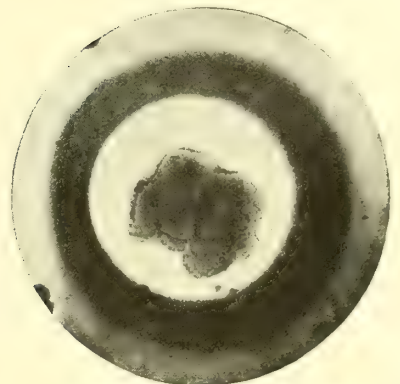


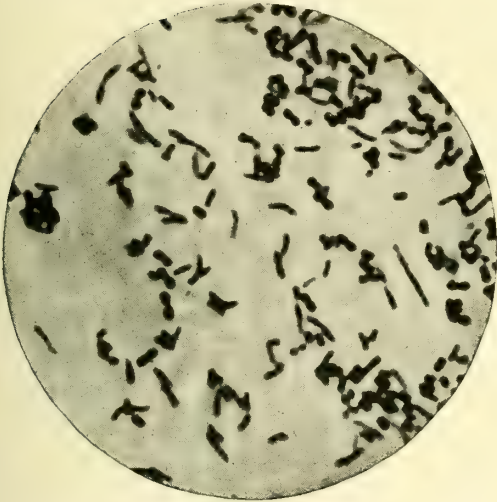
Plate colony of air micrococcus; fluidifies gelatine.  $\times 50$ .





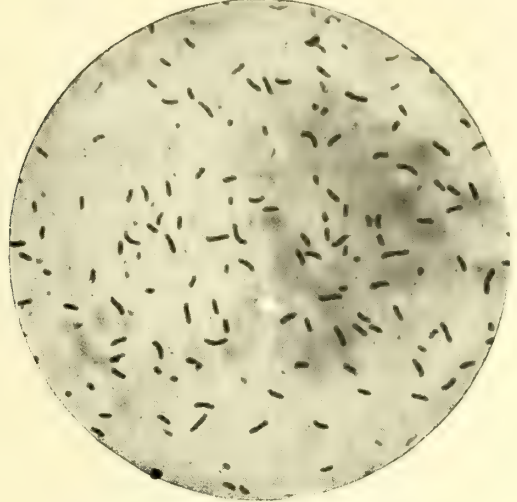
B.—ILLUSTRATION No. 17.—PHOTOGRAPHS.

PHOTOGRAPH No. 8.



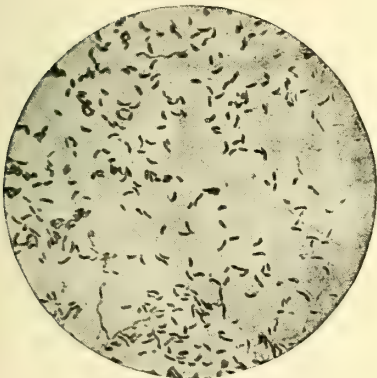
Bacteria in decomposing bouillon. A few curved bacilli.  $\times 800$ .

PHOTOGRAPH No. 9.



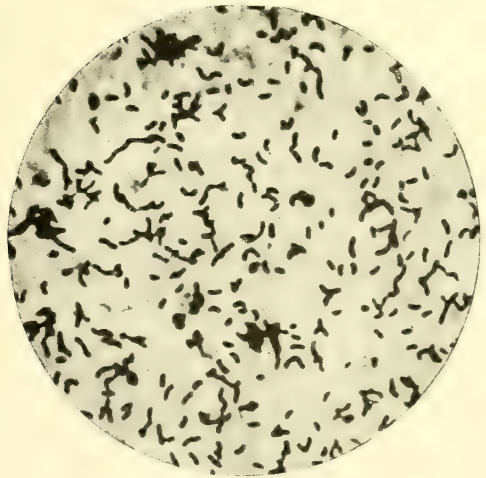
Curved bacilli of decomposed bouillon.  $\times 800$ .

PHOTOGRAPH No. 10.



Comma bacillus of Koch.  $\times 700$ .

PHOTOGRAPH No. 11.



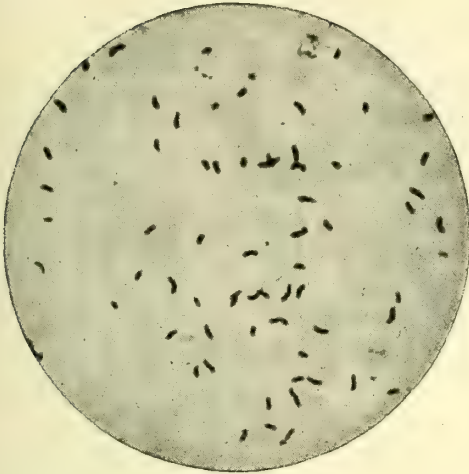
Comma bacilli of Koch.  $\times 1200$ .





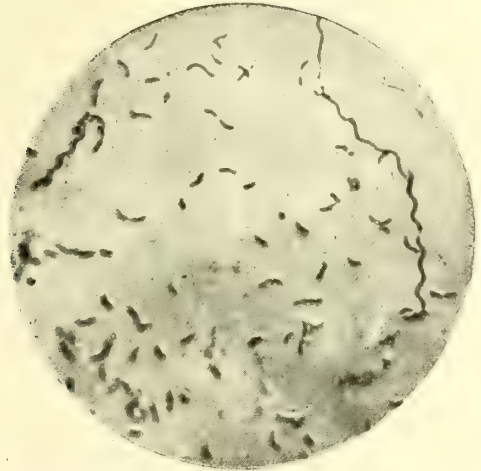
C.—ILLUSTRATION No. 17.—PHOTOGRAPHS.

PHOTOGRAPH No. 12.



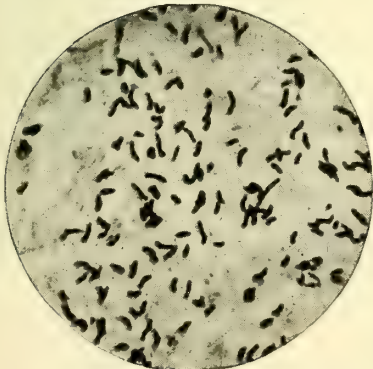
Curved bacilli of Belmonte well-water.  $\times 120$ .

PHOTOGRAPH No. 13.



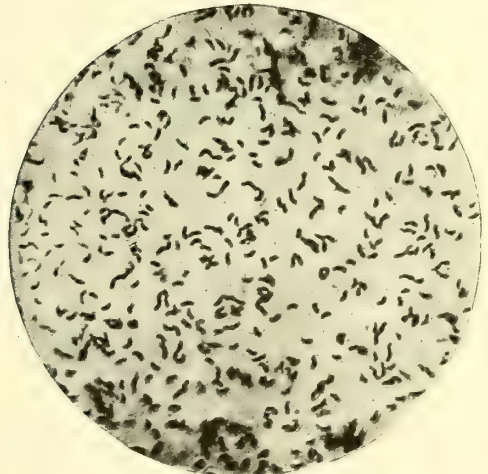
Curved bacillus of Finkler-Prior.  $\times 1200$ .

PHOTOGRAPH No. 14.



Curved bacillus of Deneke.  $\times 1200$ .

PHOTOGRAPH No. 15.



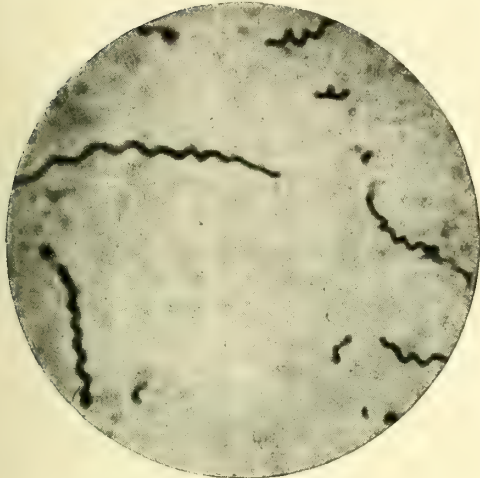
Curved bacillus of Deneke.  $\times 1000$ .





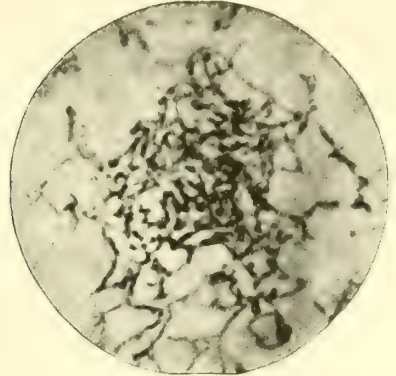
D.—ILLUSTRATION No. 17.—PHOTOGRAPHS.

PHOTOGRAPH No. 16.



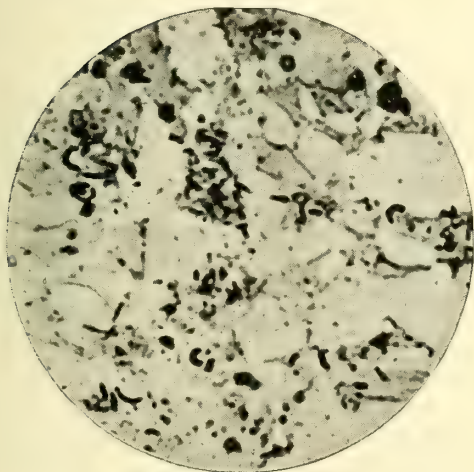
Spirillar form of comma bacillus of Koch.  $\times 1500$ .

PHOTOGRAPH No. 17.



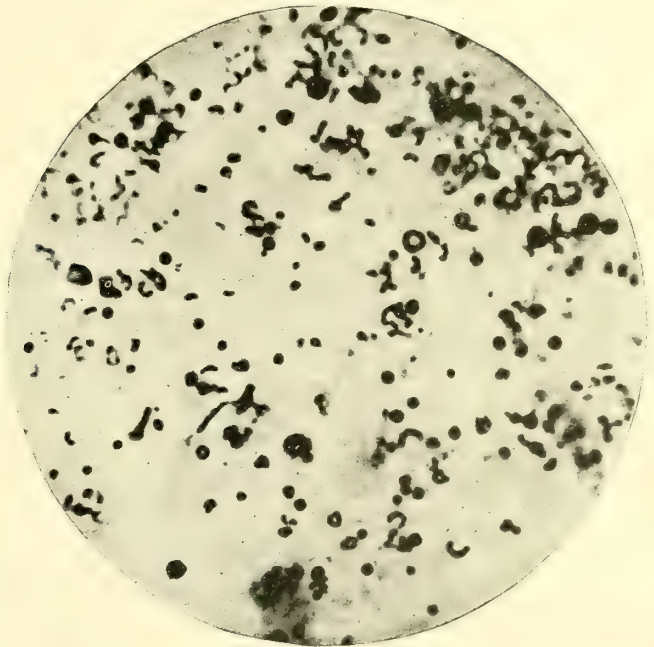
Mesh of spirilli of comma bacillus of Koch.  
 $\times 1000$ .

PHOTOGRAPH No. 18.



Comma bacilli of Koch, much enlarged. Old culture.  $\times 1200$ .

PHOTOGRAPH No. 19.



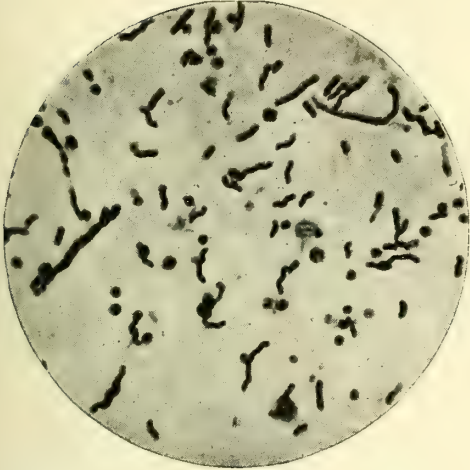
Comma bacillus of Koch. Old culture. Spirilli, circles, and oögonia of Ferrán.  
 $\times 1200$ .





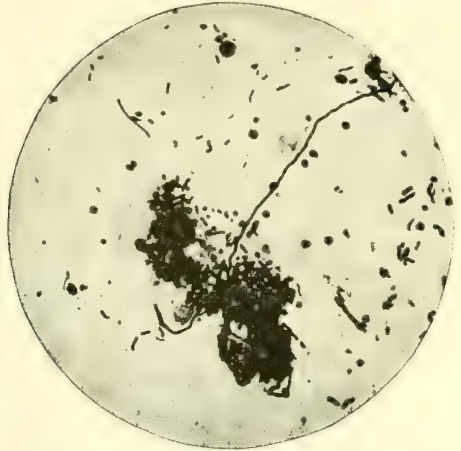
E.—ILLUSTRATION NO. 17.—PHOTOGRAPHS.

PHOTOGRAPH No. 20.



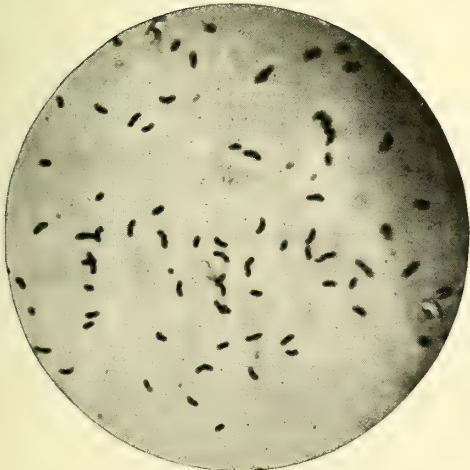
Comma bacillus of Koch, 10 days old, showing spirilli and oögonia of Ferrán.  $\times 1200$ .

PHOTOGRAPH No. 21.



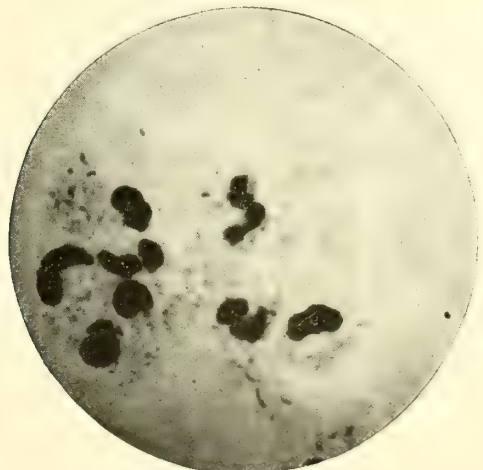
Comma bacillus of Koch, from negative of Ferrán, showing spirilli and oögonia.  $\times 1000$ .

PHOTOGRAPH No. 22.



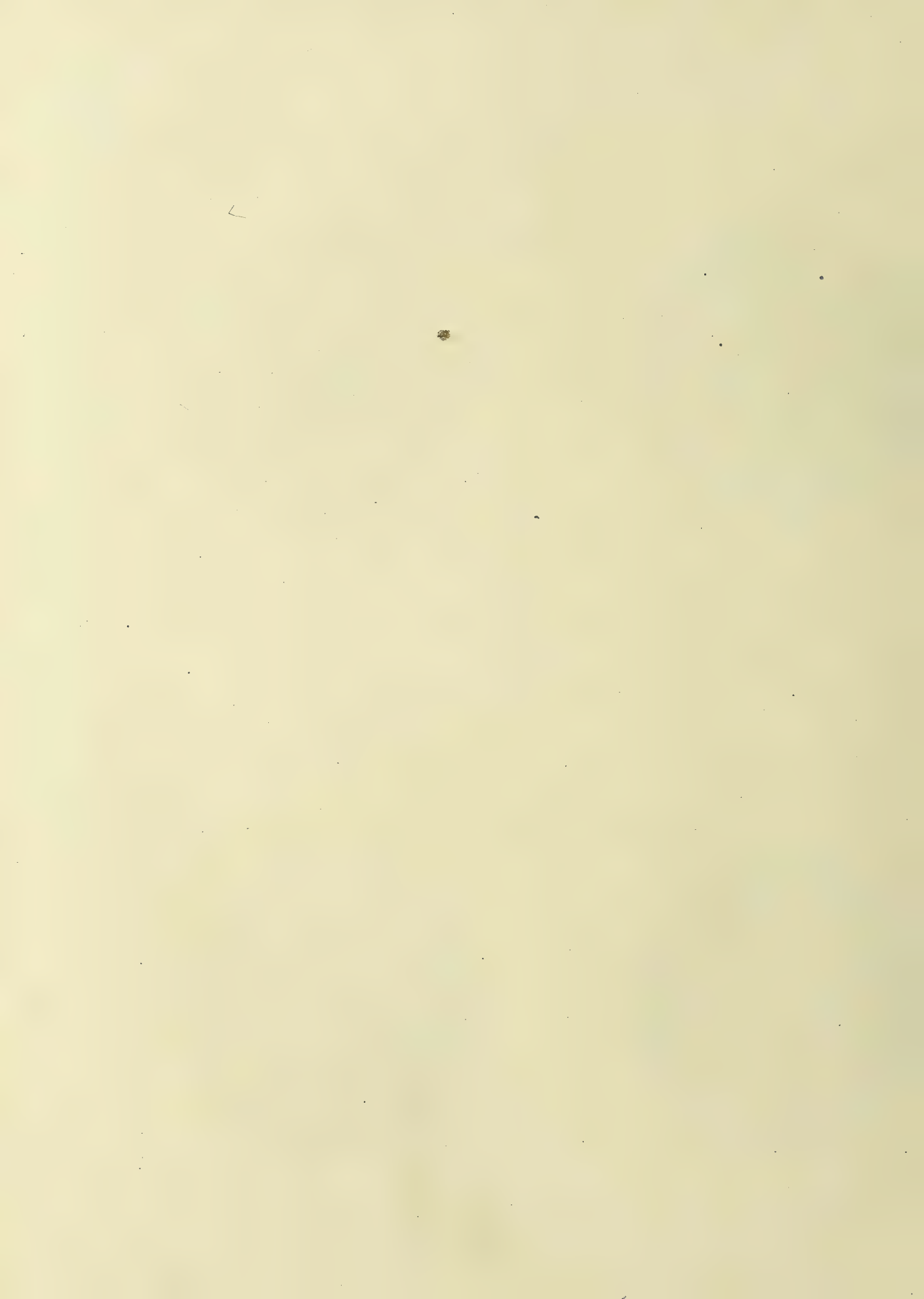
Curved bacillus of Miller, from the mouth.  $\times 1200$ .

PHOTOGRAPH No. 23.



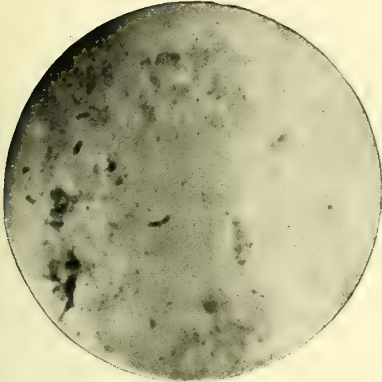
Curved bacilli from uterine ulcer.  $\times 1200$ .





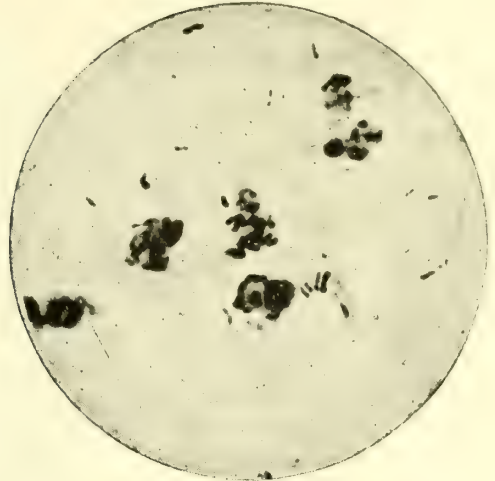
F.—ILLUSTRATION No. 17.—PHOTOGRAPHS.

PHOTOGRAPH No. 24.



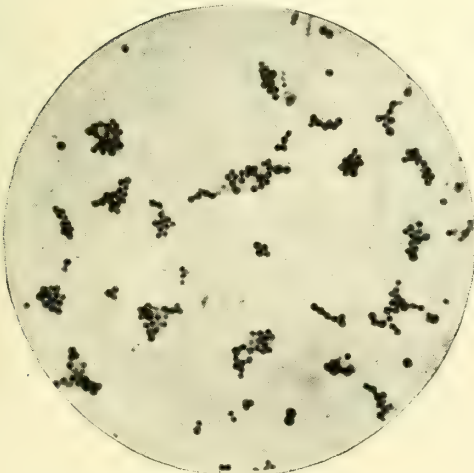
Curved bacillus from intestinal ulcer; dysente  
x 1200.

PHOTOGRAPH No. 25.



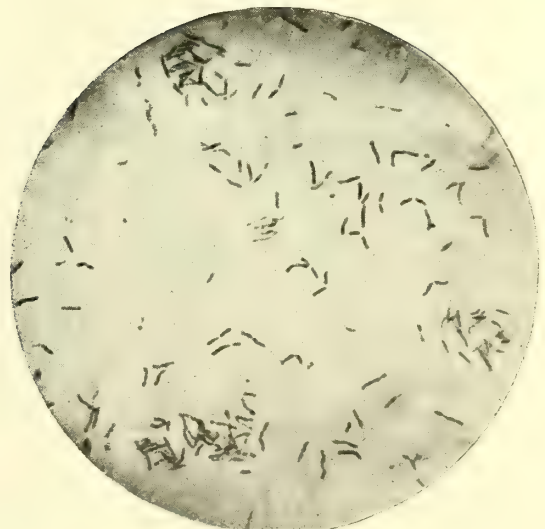
Curved bacillus from exudate in human lung—croupous  
pneumonia. x 1200.

PHOTOGRAPH No. 26.



Air micrococcus which liquefies gelatine; colony resembles  
that of comma bacillus of Koch. From colony of Photo-  
graph No. 7. x 1200.

PHOTOGRAPH No. 27.



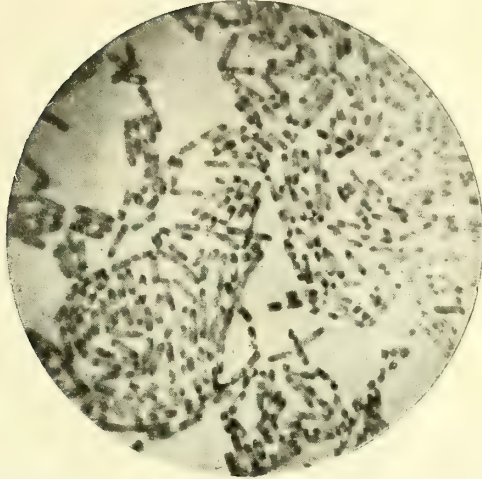
Bacillus tuberculosis. x 1200.





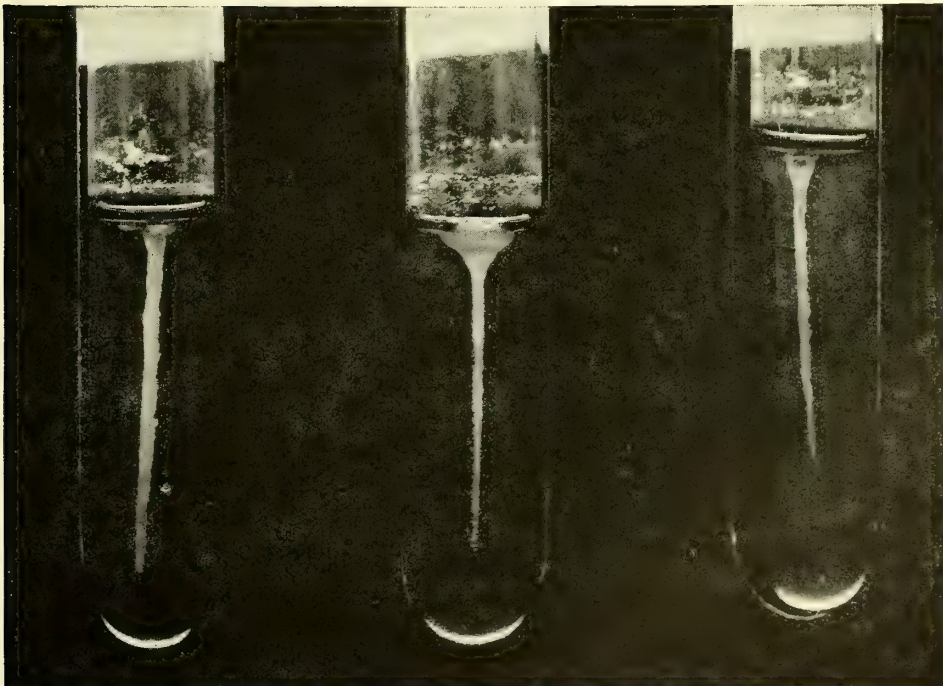
G.—ILLUSTRATION No. 17.—PHOTOGRAPHS.

PHOTOGRAPH No. 28.



*Bacillus typhosus*, from culture from human spleen during life.  $\times 1200$ .

PHOTOGRAPH No. 29.—TUBE-CULTURES. NATURAL SIZE.



Curved bacillus of Deneke.  
48 hours.

Curved bacillus of Finkler.  
48 hours.

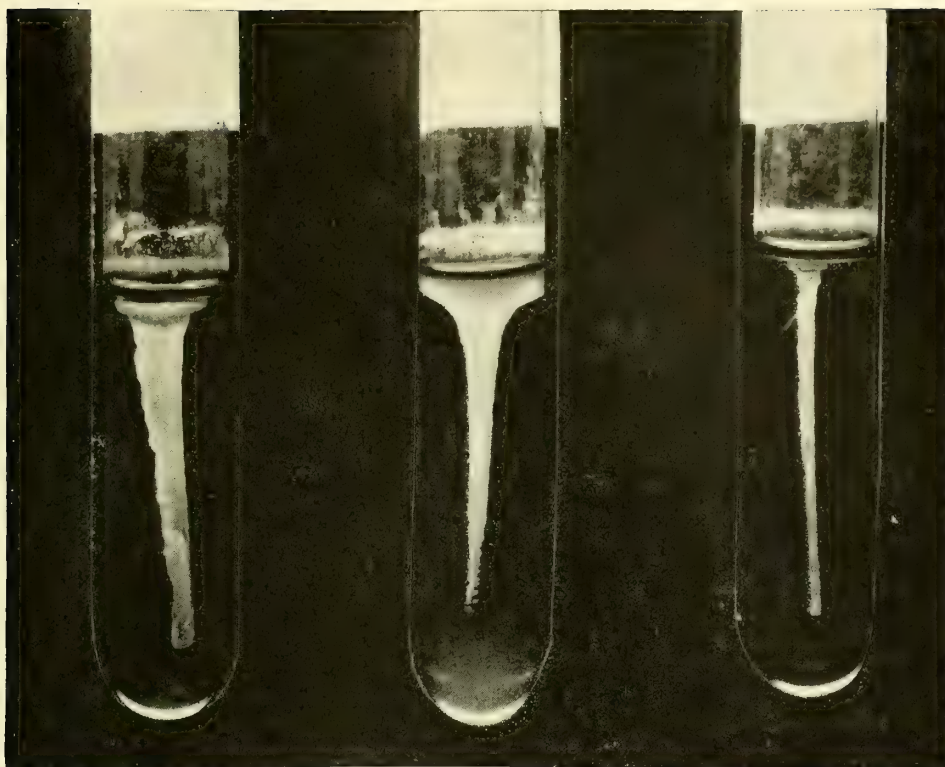
Comma bacillus of Koch.  
48 hours.





H.—ILLUSTRATION No. 17.—PHOTOGRAPHS.

PHOTOGRAPH No. 30.—TUBE-CULTURES. NATURAL SIZE.

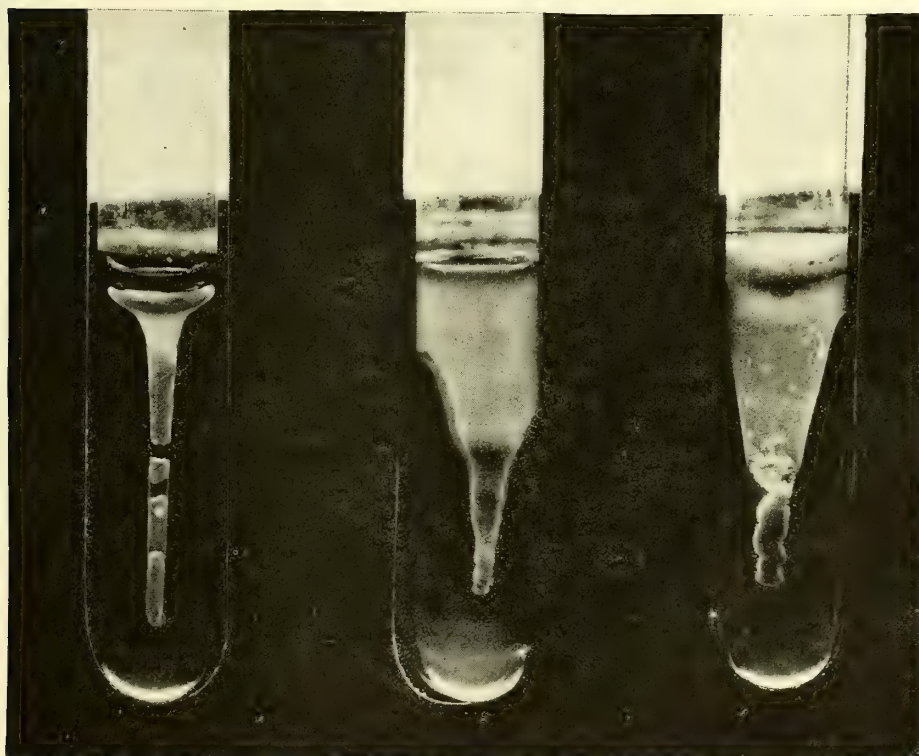


Curved bacillus of Deneke.  
60 hours.

Curved bacillus of Finkler.  
60 hours.

Comma bacillus of Koch.  
60 hours.

PHOTOGRAPH No. 31.—TUBE-CULTURES. NATURAL SIZE.



Comma bacillus of Koch.  
90 hours.

Curved bacillus of Finkler.  
90 hours.

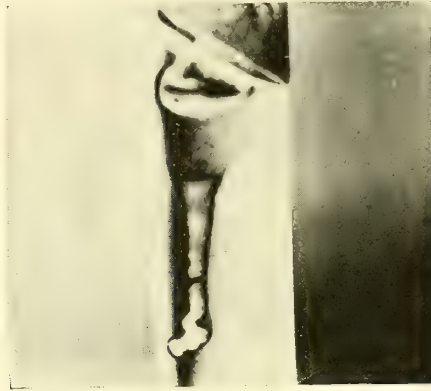
Curved bacillus of Deneke.  
90 hours.





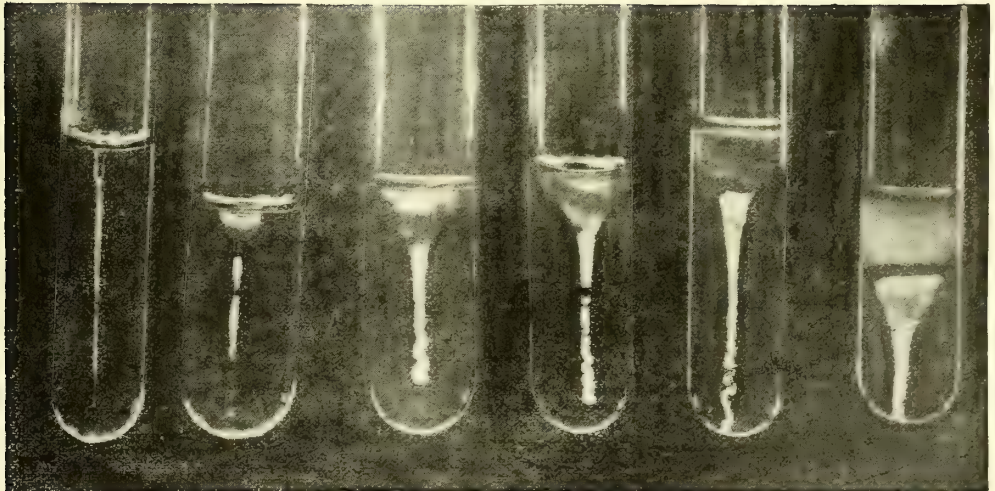
I.—ILLUSTRATION No. 17.—PHOTOGRAPHS.

PHOTOGRAPH No. 32.—TUBE-CULTURE. NATURAL SIZE.



Comma bacillus of Koch. 72 hours. Surface of gelatine inclined.

PHOTOGRAPH No. 33.



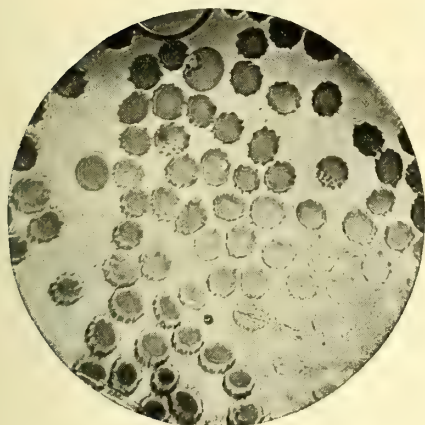
Photographic reproduction of series of comma bacillus tube-cultures of gradually increasing age. Tube to left 24 hours. Copied from Gaffky's official report.





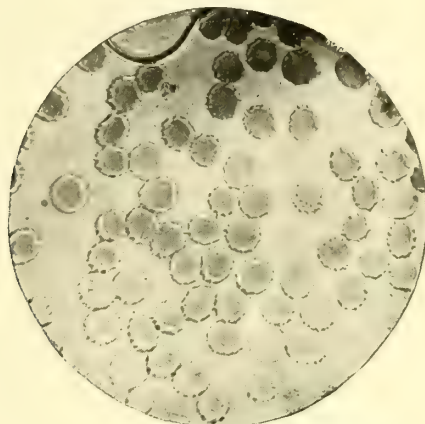
J.—ILLUSTRATION No. 17.—PHOTOGRAPHS.

PHOTOGRAPH No. 34.



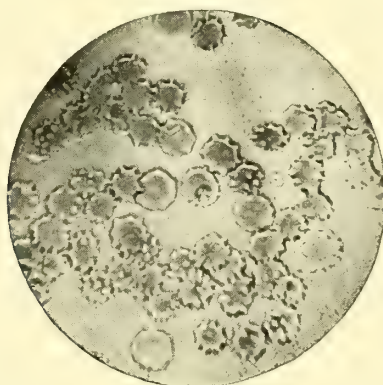
Plasmodium malariae in human blood.

PHOTOGRAPH No. 35.



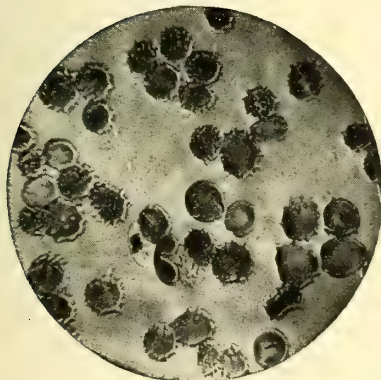
Plasmodium malariae in human blood. Same field as No. 34, but 10 minutes later.

PHOTOGRAPH No. 35½.



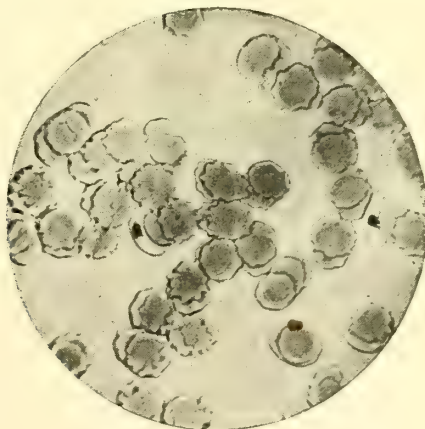
Plasmodium malariae: intradisk form shown in the central globule.

PHOTOGRAPH No. 36.



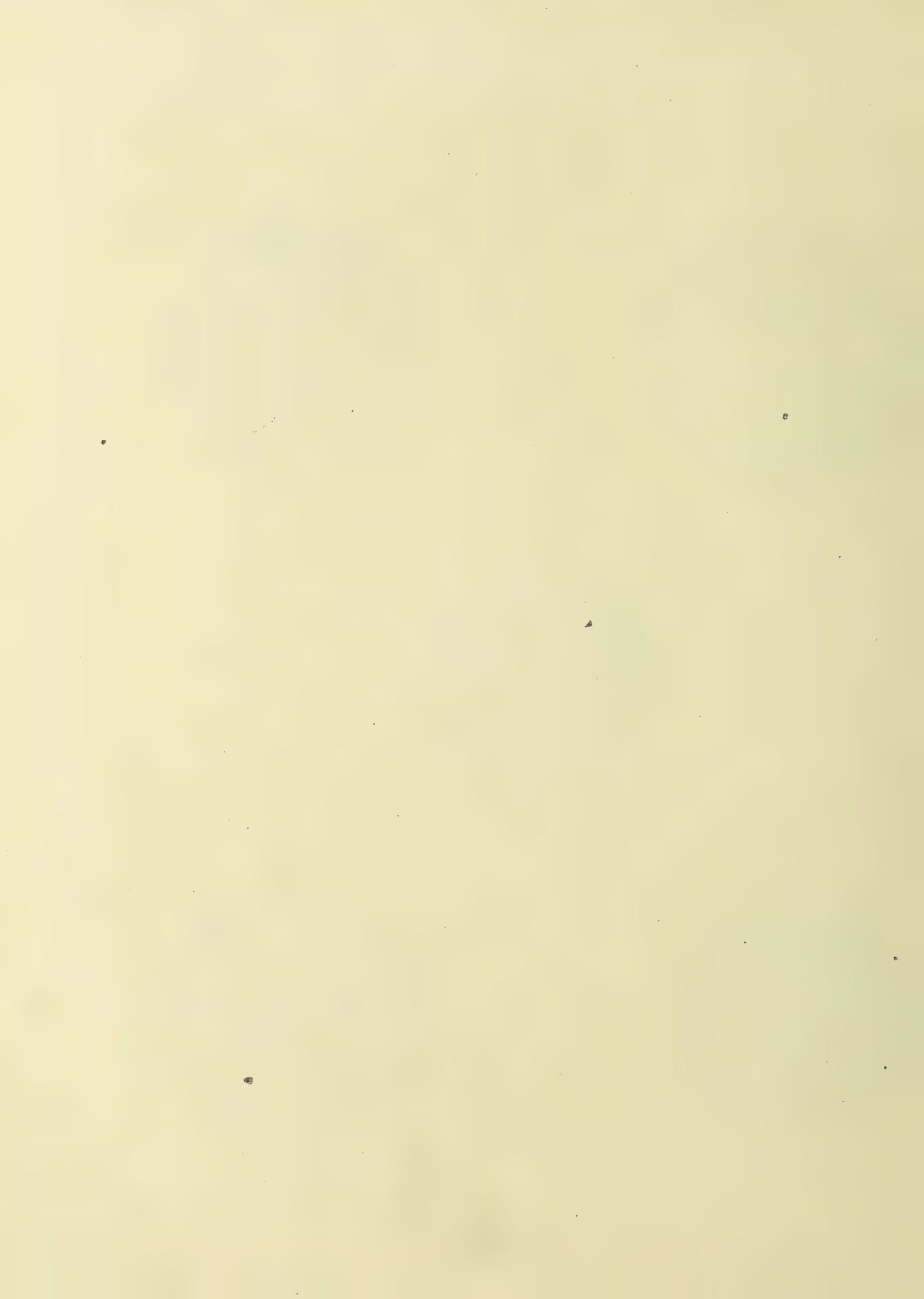
Crescentic form of plasmodium malariae in human blood.

PHOTOGRAPH No. 36½.



Crescentic form of plasmodium malariae in human blood.





# ILLUSTRATION NO. 18

FIG. 1.

Contents of the ileum, human cholera,  
rapid case  
× 1200



FIG. 2.

Contents of the ileum, human cholera,  
rapid case  
× 1200



FIG. 3.

From culture of comma bacilli  
× 500



FIG. 4.

Pure culture of comma bacilli  
× 1200



FIG. 5.

Comma bacilli  
× 500



FIG. 6.

Comma bacilli  
& spirilli × 500



FIG. 7.

Spirilli & oögonia of Ferran  
culture of asiatic cholera  
× 800

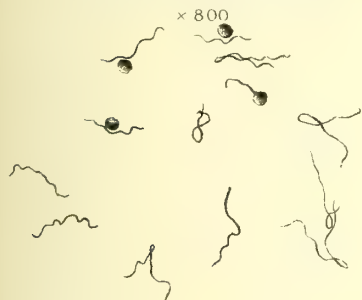


FIG. 8.

Finckler and Prior's bacilli &  
spirilli × 800



FIG. 9.

Deneke's cheese bacilli  
× 500



FIG. 10.

Deneke's cheese bacilli  
× 500

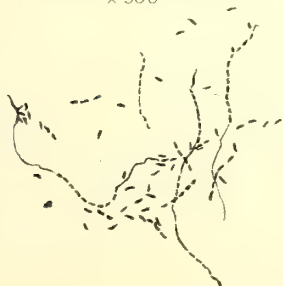


FIG. 11.

Helio-bacilli of the stomach  
× 500







# ILLUSTRATION NO. 19.

FIG. 1.

Cholera bacillus Colonies

Gelatine plate. 48 hours

x 50 diam

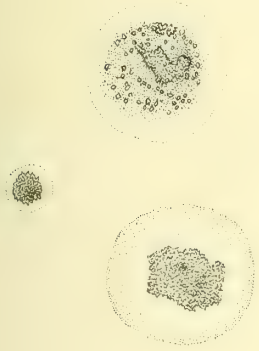


FIG. 2.

Deneke or cheese bacillus Colonies

Gelatine plate. 36 hours

x 50 diam

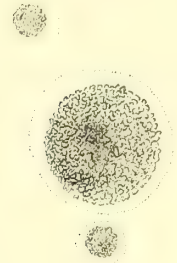


FIG. 3

Finkler-Prior bacillus Colonies

Gelatine plate. 24 hours

x 50 diam

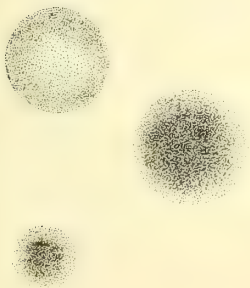
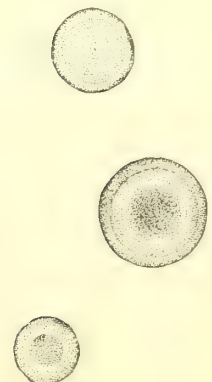


FIG. 4

New curved bacillus Colonies (Belmonte)

Gelatine plate. 48 hours

x 50 diam







# ILLUSTRATION NO. 20.

## TUBE-CULTURES.

FIG. 1.

CHOLERA BACILLUS 48 hours  
5% Gelatine

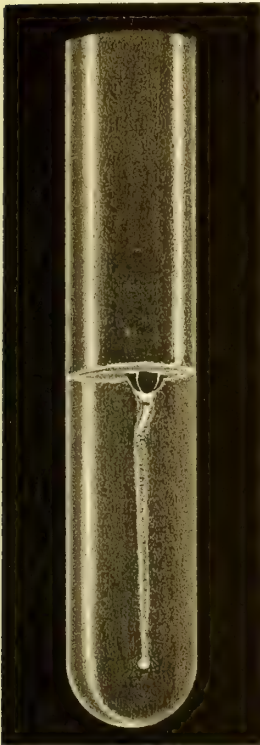


FIG. 2.

CHOLERA BACILLUS 60 hours  
5% Gelatine

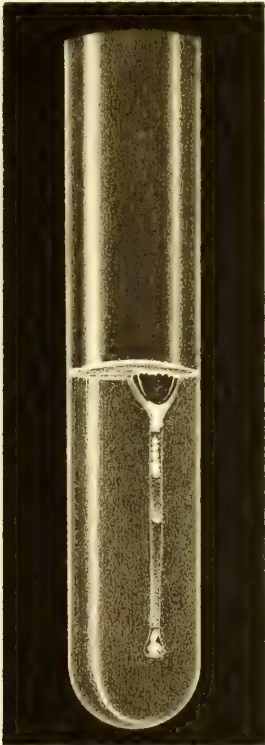


FIG. 3.

CHOLERA BACILLUS 72 hours  
15% Gelatine

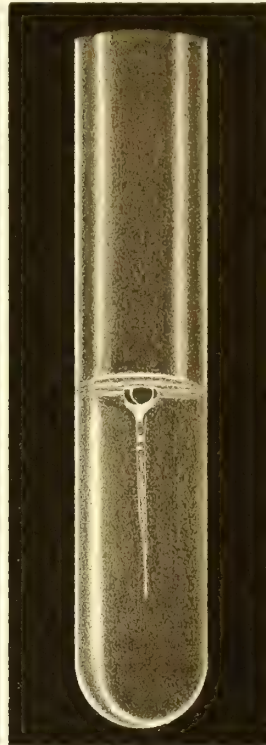


FIG. 4.

DENEKE CHEESE BACILLUS  
48 hours . 5% Gelatine

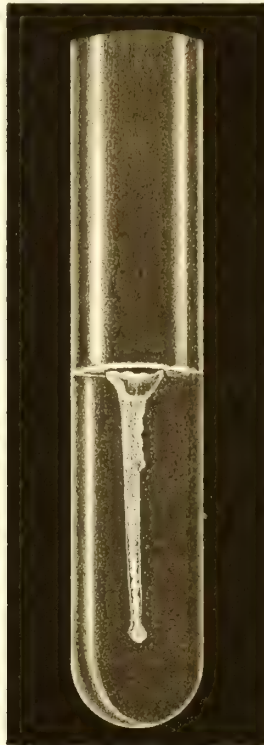


FIG. 5.

DENEKE CHEESE BACILLUS  
60 hours . 5% Gelatine



FIG. 6.

DENEKE CHEESE BACILLUS  
72 hours . 15% Gelatine

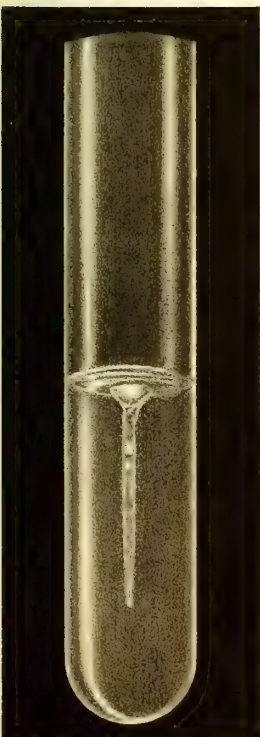


FIG. 7.

FINKLER & PRIOR 48 hours  
5% Gelatine

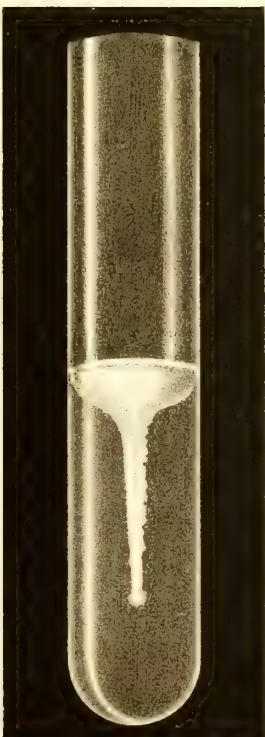


FIG. 8.

FINKLER & PRIOR 60 hours  
5% Gelatine



FIG. 9.

FINKLER & PRIOR 72 hours  
15% Gelatine

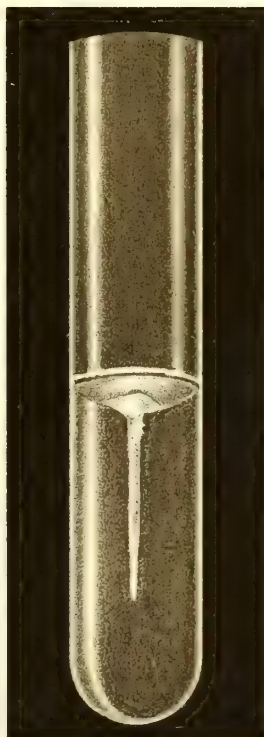
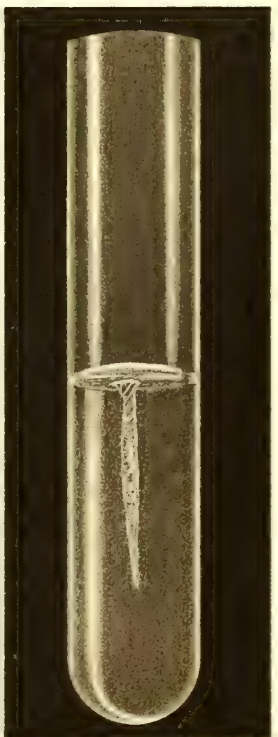


FIG. 10.

From GLASS Like PLATE COLONY  
72 hours . 15% Gelatine







## CHAPTER V.

### IMMUNITY CONFERRED BY AN ATTACK OF ASIATIC CHOLERA.

One familiar with the literature of Asiatic cholera must admit that the vast majority of authors who have made personal studies of this disease, or who have written upon the subject at second-hand, are of the opinion that Asiatic cholera does not belong to that class of diseases one attack of which confers a more or less lasting immunity from subsequent attacks. Notwithstanding the unquestionable fact that this is the prevailing opinion of authors, an examination of the numerous treatises upon this disease which have appeared in various languages since the first invasion of Europe by epidemic cholera will show that there have been occasional authors of the greatest renown who have expressed the belief, in unequivocal language, that there does exist such an immunity of longer or shorter duration. In support of this statement I deem it proper to introduce below the following quotations, and it will be observed that the names of some of the most distinguished writers in the literature of medicine are to be found among them.

---

### SECTION 1.

#### HISTORY OF OPINIONS CONCERNING IMMUNITY PRODUCED BY AN ATTACK OF CHOLERA.

##### *THE EXISTENCE OF IMMUNITY AFTER AN ATTACK OF CHOLERA—HISTORICAL.*

Among the early writers is MOREAU DE JONNES (*Mem. ou traité sur le choléra pest.*, 1832), who says:

When cholera shows itself the second time in a town, its mortality is not extensive, neither does it spread as much as in the first invasion; and, if a few rare or doubtful cases are excepted, it does not attack the same individual twice, although he finds himself under the same conditions as when he contracted the disease.

SÁMANO (*Monografía del cólera morbo asiático*, Madrid, 1858, 2 vols.) states (2d vol., p. 251) that:

Genuine cases of relapse are few, and recurrences are still more rare.

LEBERT also most firmly defended his opinion, based upon careful investigation, that an attack of cholera confers immunity.

The following is the result of the deliberations concerning immunity of the International Hygienic Conference of Constantinople:\*

The conference declares in a general manner: The crowding together of people among whom cholera is introduced is a condition favorable to the rapid extension of the disease and to the violence of the epidemic among them, if this crowding together occurs under bad hygienic conditions. Under such influences the rapidity of the extension is proportional to the concentra-

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\*Report of the conclusions adopted by the International Sanitary Conference of Constantinople, 1866.



tion of the crowding, whilst the violence of the epidemic, all other things besides being equal, is so much the more pronounced as the individuals constituting the crowd have been the less subjected to the choleraic influence or have been entirely free from it; that is to say, in other words, that the individuals who have been subjected to the influence of the choleraic focus enjoy a sort of immunity, relative or temporary, which counterbalances the evil effects of the crowding.

Finally, among masses of people the more rapid the extension the more prompt is the cessation of the epidemic, unless new arrivals furnish new materials for the disease to feed upon.

Adopted by 20 votes against none, 2 abstaining.

As to ships, the conference concludes that the intensity of epidemics of cholera aboard ships crowded with men is, in general, proportional to the crowding, and (other things being equal) is the more violent if the men have not come from choleraic localities where they have sojourned.

Concerning lazarettos, the conference affirms that the crowding of individuals coming from a place where cholera is raging into the lazaretto does not have the effect to produce among those quarantined much extension of the disease, but that such crowding is nevertheless very dangerous for the neighboring country.

Concerning great numbers of people (armies and pilgrimages), the conference declares that they are one of the surest means of the propagation of cholera; that they constitute large epidemic *foci*, which, whether they march as an army or spread out like pilgrims, import the disease into the country they traverse; that after having undergone in a rapid manner the influences of cholera, they become much less insensible to it, and that then the disease promptly, even very rapidly, disappears from among them unless new arrivals keep the disease alive.

GRIESINGER (*Traité des Maladies Infectieuses*, Traduit d'après la deuxième édition allemande et annoté. Paris, 1868) concerning immunity from cholera thus expresses himself (page 440):

A first attack of cholera in the majority of cases very greatly lessens susceptibility to the disease even for a long time, but it does not completely destroy it; there are numerous examples of recurrences and what is more in the same epidemic; it may even happen that an individual contracts cholera three times. A genuine recurrence after the establishment of convalescence sometimes happens, but it is very rare. The fact of being subjected for a long time to the action of the choleraic miasm appears to diminish the predisposition to the disease during epidemics; strangers who arrive in a locality at a time when the epidemic is raging, those who have fled from the cholera and return, appear to be more easily attacked than the persons who have remained permanently exposed to the infection.

And this author corroborates his opinion respecting immunity in other paragraphs; thus he says, speaking of cholera:

It may be admitted that there is, with reference to infection, a progressive habituation which moderates the effects. Many other facts speak in favor of this hypothesis.

And in still another place (page 515) is found the following paragraph:

A relapse of the disease at the commencement of convalescence is often observed, especially following imprudences of diet; genuine recurrences after a complete cure are extremely rare.

COLIN (*Traité des Maladies Epidemiques*. Paris, 1879, p. 850) is committed against immunity, as can be seen by the following:

A first epidemic of cholera only momentarily lessens the susceptibility of the population; individual attacks conferring no lasting immunity, this affection will not show disappearances for years, like small-pox, typhoid fever, the plague, and yellow fever; certain cities have been attacked eight and ten times in less than forty years.

And further (p. 373):

Among contagious diseases cholera presents even outside its original focus (or endemic area) a special tendency to reappear at short intervals; certain cities have been many times

the theater of epidemics of striking gravity—ten or twelve times from 1830 to 1873. [I would suggest that the same can be said of nearly all those infectious diseases which are admittedly followed by a period of immunity. E. O. S.] It differs from the majority of other such diseases of this kind in that a previous attack does not confer any immunity.

Yet in the same book facts concerning cholera are related by Colin which very strongly conflict with the opinion above quoted. Thus (p. 295): “Why are soldiers more particularly susceptible to the influences of miasmatic foci? Is it not because they have generally recently arrived at these foci, recently arrived in those cities where typhoid fever reigns, recently arrived in regions infested with malaria, recently arrived, in fine, in localities where yellow fever or cholera, being already at the point of extinction among the old residents, appears to have its germs revived by contact with those who have not the advantage of being accustomed to them? \* \* \* At the close of the Crimean war (1854–1856) cholera no longer attacked the troops accustomed to the epidemic influence, but continued its ravages only among the regiments newly arrived. And (p. 857): \* \* \* This influence (or peculiarity) has been manifested in a much more surprising manner in certain military epidemics which have maintained themselves, so to speak, by the arrival of fresh troops within localities attacked by cholera.

In a foot-note explanatory of this last declaration, Colin states that in Constantinople in 1854, when the epidemic no longer afflicted the soldiers who had arrived at the commencement of the war, it kept itself alive by preying upon the regiments incessantly arriving from France.

PROUST (*Le Choléra: Etiologie et Prophylaxie*, Paris, 1883; page 120 et seq.): thus discusses the question of immunity.

This immunity, the result of habituation, is also met with among those quarantined in lazarettos. This observation was very remarkable during the epidemic of 1865. A very large number of persons indeed had fled the epidemic; they could not land because of measures prescribed by the Ottoman Government; they were placed in lazarettos and were greatly crowded. Notwithstanding this crowding, notwithstanding the evidently bad hygienic conditions, there were very few cases of cholera among them, and the mortality was very slight, because these individuals fleeing from choleraic foci had already undergone the choleraic influence. They were habituated. In several lazarettos, at Salonia, at the Dardanelles, at Trebizonde, at Beyrouth, the crowding was very great. At this moment, eleven lazarettos had received 35,819 of the quarantined. Of this enormous number there were only 480 attacked with cholera, and only 238 deaths. It should also be added that among these attacks, a pretty large number, cholera did not break out at the lazaretto, notwithstanding the fact that some individuals were suffering from attacks of cholera at the time of arrival.

Sometimes, disobeying the rules, a person attacked with cholera or carrying with him the germ of the disease would communicate with the neighboring population, then untouched by the choleraic influence. These cases were only the verification of the law of habituation to cholera. They would mingle with those in quarantine and experience no disturbance themselves but, by communication with the neighboring town, could cause an epidemic to break out there which will be as much more severe, as the inhabitants have not at all undergone habituation to the choleraic influence.

We find still again the confirmation of this law of habituation in that which takes place in armies, great fairs, and pilgrimages: when the cholera is imported into these large agglomerations, if they have not been subject to the choleraic influence, the explosion is rapid among them, the mortality great; but this explosion lasts only a few days and the disease soon ends.

The war of the Crimea furnishes us an example of the rapidity of development and the intensity of the disease among ships previously free from any choleraic influence. We will find an identical argument á propos of the invasion of the land troops by the epidemic.

At the commencement of April, 1855, there arrived in Constantinople from France 15,000 to 20,000 troops, composed in part of the Imperial Guard. These troops had not during their journey a single case of cholera. They were encamped upon the heights of Masslak, in an extremely salubrious situation. At this moment in the city of Constantinople there were only



very rare attacks of cholera; the reports of the French military hospitals showed only 53 cases for the month of March, and the report for the 11th of April did not show one. In the Crimea the attacks were then also of little frequency. These troops were scarcely installed at Masslak when in the night of the 14th to the 15th of April cholera broke out among them, and there followed an epidemic of some gravity.

Finally, we have remarked that cholera affects especially populations which have been free from every choleraic influence, and that it is among them, the non-habituated, that the explosion is most rapid and violent.

In fine, another source of immunity is found in habituation which, of itself, as we have seen, counterbalances unfortunate hygienic conditions and crowding.

This question of immunity has just been the object of an important study by M. Fauvel, (*Acquisitions scientifiques récentes concernant l'étiologie et la prophylaxie du cholera. Mémoire lu à l'Académie des sciences, Paris, 1883*), which he concludes with the following propositions:

“(1) The ports of India where cholera is endemic are never the theater of a great epidemic;  
“(2) This fact is due to a general immunity, but not absolute, which the native population of these ports enjoy;

“(3) This immunity does not exist in the endemic foci for strangers to the locality who are under conditions which predispose them contract cholera; such are, in particular, the Musulman pilgrims who come to Bombay to embark for Mecca.

“(4) The cholera epidemics which develop in the regions of India where the disease is not endemic come from endemic foci and are favored by the Hindoo pilgrimages.

“(5) The epidemics observed among the pilgrims to Mecca also proceed from foci of endemic cholera.

“(6) A grave epidemic of cholera confers upon the country or the locality of which it has been the theater an immunity more or less complete and more or less lasting, of which it is impossible to formulate the law for Europe but which in India appears to last for several years.

“(7) In Hedjez and, in general, in the sparsely populated regions of Arabia, cholera has only a slight tendency to propagate itself among the native population.

“(8) The existence of a large epidemic of cholera, in any country whatever, is a proof that the disease is not endemic there.”

Indeed, the facts newly acquired by science relate to questions of immunity, and illuminate them from a side heretofore unknown. New indications concerning the etiology and especially the prophylaxis of cholera may be deduced from them.

These facts, moreover, appear to be the expression of a law which embraces the whole of another special category of pestilential diseases due to a contagium and followed by an immunity more or less lasting.

KOCH (*Die Conferenz zur Eroerterung der Cholerafrage, 1884*) thus expresses himself:

Concerning a question affecting the etiology of cholera, which has more than a theoretical interest, I have not yet had the opportunity to express myself, and must even now only briefly discuss it. It relates to the explanation of the remarkable fact that outside of India cholera always soon disappears.

It appears to me that several factors enter into the solution of the question.

First, I hold it as established, that individuals, as with many other infective diseases, acquire a certain immunity by once suffering an attack of cholera. This immunity does not appear to be of long duration, for there are quite a number of examples where a person who was attacked during one epidemic experienced cholera the second time during another epidemic; but one very seldom hears of any one being attacked twice during the same epidemic of cholera. Yet cholera is just the disease which should more frequently recur, because the person who is cured of one attack is generally in a few days back again in the same conditions and always again exposed to the same dangers and the same infection. Besides this, some investigations made in India indicate that a certain immunity is acquired by suffering from cholera. Now,

in the same way that an individual can acquire immunity, so can also a locality become immune for a certain time, which may be longer or shorter, as many investigations show. One often sees that, if cholera attacks a place and ravages it, and then in the next year returns, this place almost always remains free or is only very lightly attacked.

LEYDEN (*Die Conferenz zur Eroerterung der Cholerafrage*, 1884) says :

A certain immunity against a second attack appears to follow after a first attack of cholera. Nevertheless this immunity is not absolute. Repeatedly has it happened that persons in different epidemics have suffered twice and even three times from cholera and then the subsequent attack has been fatal. They had not acquired a lessened receptivity for cholera; on the contrary, according to my information, very seldom is it that the same patient is attacked during the same epidemic soon after a previous attack of cholera. Such a case, however, I observed in Königsberg during the cholera epidemic of 1866. It is described in the dissertation of Dr. Wiwiorowski. The patient was treated by me in the hospital, so that there can be no doubt of the diagnosis. He was attacked the first time on the 13th of August and was discharged on the 20th, and then after sixteen days, that is on the 5th of September, he returned and died of cholera. Koch, commenting upon the observations of Leyden, interjected the remark: Nevertheless, it is certain that such cases must be extremely few.

KOCH (*Conferenz zur Eroerterung der Cholerafrage*, zweiter Jahr., 1885), in speaking of the periodicity of cholera as compared with malaria and variola, says:

With the notion that cholera may be regarded as a kind of malarial disease, I can not accord. Many facts speak against it: thus, above all, the dependence of cholera upon human intercourse. Next, the epidemiological behavior of cholera, which far more closely relates it to the specific infectious than to malarial diseases. In how far this is the case I will endeavor to show you by a graphic chart of the cholera, variola, and malaria mortality in the Presidency of Bombay. [Presented a chart.] These yellow lines show the yearly mortality by malaria from 1870 to 1883. The total deaths remain during this period about the same, and no periodical decline is indicated. These red lines give the mortality from variola. With them a quite distinct periodical change is seen; after a year of great mortality follow several years with less mortality. Then we come again to a decided epidemic, and so on, in periods which comprise five or six years. If now we compare cholera, which is indicated by the black lines, on the one side with malaria, and on the other side with variola, we shall remark also in the yearly mortality from cholera a very pronounced periodic type.

This periodical behavior of cholera is up to the present far too little appreciated. It has the most important influence upon the course of cholera in India, and by reference to it certain peculiarities of cholera in India may be easily explained.

The periodicity of cholera warrants the inference that there is an immunity following recovery from the disease, a point concerning the significance of which we will discuss later. Cholera is therefore in this respect in the same class with the genuine infectious diseases, such as variola, scarlatina, etc., and has no similarity to malarial diseases in which a protective immunity will not be observed. \* \* \*

Finally, Cuningham (the recent surgeon-general of India) leaves entirely out of consideration an extraordinarily important point, in my opinion, in discussing the behavior of India cholera, that is, namely, the immunity which the individual as well as a whole population enjoys after having experienced an attack of cholera.

I have already in our first conference and also in the present one taken the opportunity to agitate this question, the thorough discussion of which I would especially recommend.

An extensive invasion of the population of India leaves behind it an immunity of about three to four years duration, after which time always a new epidemic, wavelike, again spreads out from its endemic resting place, pursuing the main highways of commerce towards the north-west of India. Bryden first thoroughly studied these three to four year periods of the curves of cholera prevalence and sought to graphically indicate them. He did not, however, discover the correct explanation of these appearances, but he thought that they owed their origin to the



monsoon. It is not conceivable that the monsoon, which blows year after year, shall pause always for periods of three to four years in order to convey the cholera out of Bengal into the northwest.

A satisfactory explanation for this remarkable characteristic can be given only in the manner already indicated by me, mainly through the influence of the immunity which follows extensive ravages of the disease. We already know from our own observations that a recurrent attack of a person in one and the same epidemic happens with the extremest rarity, although the patients after recovery in the locality where they were infected remain there, or, if they have recovered in a cholera hospital, return and again expose themselves to the influence of the infectious material, which in so short a time has not yet become inactive. Without the acceptance of a protective immunity through recovery from the disease, this circumstance is not explainable.

I doubt not that if any one will graphically indicate the course of the variola epidemics in any country, he will obtain figures very like the cholera curves of Bryden. The return of the wave in this case would be only a little later than with cholera, because the periodical rise of the variola epidemic occurs only after a period of five to six years.

Without taking into account an acquired immunity against cholera, it is also impossible to correctly understand the relation between cholera and the movements of pilgrims. Cunningham (the recent surgeon-general) undertakes to prove the independence of outbreaks of cholera and movements of pilgrims, because cholera so seldom spreads from Hurdwar, where frequently hundreds of thousands, and even millions, of pilgrims assemble, and yet if it is conveyed by the pilgrims it is only in one direction, namely, towards the northwest, corresponding to the direction of the monsoon.

I find this circumstance by no means so difficult to explain, and without the help of the monsoon. If I conceive that the population is visited by cholera at given times, and possessed of a greater or lesser immunity, then I find it quite natural that the cholera, if it spread from Hurdwar with the pilgrims, can be transported only in the direction where the immunity fails. Besides this it is also to be remembered that the pilgrims who come together at the place of congregation have not equal susceptibility. If they come from an infected district or from Bengal, the endemic habitat of cholera, they are already, and on that account, less susceptible, and therefore can not carry the cholera back to their infected homes, because there is there a population which is temporarily immune. From this it follows that from Hurdwar the cholera can not radiate regularly in all directions, as Cunningham would have it, but must pursue its way towards the northwest, where it has before it the least infected population of India.

Similar observations, which accord with this view, were made during the Crimean war. It is shown that after the French army was swept by the cholera the disease almost entirely vanished. But every time when fresh troops arrived the epidemic preyed upon the new comers; the old troops enjoyed a certain immunity and remained free from these later outbreaks of cholera. The same peculiarity has been already frequently demonstrated where many people have fled a place infected by cholera and have returned at the decline of the epidemic. In this case also cholera again breaks out among the returned refugees without the inhabitants who have already been subjected to the influences of the epidemic being attacked in like proportion.

Many examples could still be cited, all of which prove, by the strongest testimony, that an immunity of a certain duration remains after experiencing the ravages of cholera. \* \*

Again, I return to the discussion of immunity. It surprises me not a little that Herr von Pettenkofer desires to know absolutely nothing further. Griesinger was a great friend of this idea: He has said, that "next to perfect health and good hygienic surroundings nothing affords greater protection than recovery from an attack of cholera." That is clearly enough expressed. And Herr von Pettenkofer has himself formerly entertained another opinion than at present. I find in one of his writings that he said: "We know that one attack of the disease almost with absolute certainty protects against a second attack." Fur-

thermore, in the Cholera Regulations published by Griesinger, v. Pettenkofer and Wunderlich is the following sentence: "When a body of troops has suffered from cholera it enjoys thereby for a long time a certain insusceptibility or immunity therefore." You see, therefore, that immunity from cholera, after experiencing its effects, is not my discovery, but that I am supported by the best authorities. In the international cholera conferences, especially in that of Constantinople, this matter was often discussed.

I mentioned yesterday the experience of the Crimean war, from which, for the further fortification of my stand-point, I desire still to bring a few examples. The cholera epidemic among the French army and fleet very rapidly reached its height; for example, five ships had lost 456 men from cholera; the whole fleet numbered 800 dead in eight days. From this time on, however, the cholera very rapidly declined, and there occurred up to the end of the war, in the French fleet, only isolated cases of cholera and slight recurrences; but, indeed, only upon such ships which carried unacclimated troops. The same was observed in the army, for every time when fresh troops came the disease again broke out. The same experience was met with during the field maneuvers of 1866, concerning which Wunderlich made an exhaustive communication to the Weimar Cholera Conference.

This experience is put to practical use in India. In the regulations for the management of troops in case of an outbreak of cholera, it is recommended to make use of native nurses, because, as is stated in a foot-note, it is an undeniable fact that the native troops much less frequently and much less severely suffer from cholera than the European troops. The nurses (or attendants upon the sick) are therefore taken from a population which has felt the influence of cholera, because it has been observed that they are much less liable to the disease. It is furthermore an old experience in India, that the recently arrived European troops are very severely attacked by cholera, occasionally even decimated, but that after they have been in India a certain time, and, as I believe, have become immune, they lose more and more their susceptibility to cholera infection. The same holds with persons aboard ship. It is certain that all of those who remain a longer time in India, for example, sail along the Indian coast, are in much less danger than those who recently arrive. According to my conviction, the so often observed periodical feature of predisposition in many cases is to be explained by the immunity which follows an invasion.

According to all our experience with other infectious diseases it is very probable that in order to acquire immunity it is not necessary to suffer the disease in its severest form, but that also a slight illness gives protection against another attack; and so I admit that slight cases of cholera also, even hardly noticed cases of cholera, which in cholera times are very numerous, can produce immunity. From this point of view a far greater portion of the inhabitants will be looked upon as having been infected than one would infer from the number of cholera cases announced or from the mortality records. Under such circumstances the acquired immunity which follows attack must therefore possess a very important influence.

HIRSCH (Conferenz zur Eroerterung der Cholerafrage, zweiter Jahr., 1885) speaks as follows concerning immunity:

Permit me upon this occasion to make a short communication concerning the sickness and mortality from cholera among the British and native troops in India. According to the statistical part of the British army reports there were, from 1862 to 1881, in the three presidencies (Bengal, Bombay, and Madras) among the European soldiers 24.96 per 1,000 attacked, and 8.40 per 1,000 died of cholera; among the Sepoys, on the contrary, only 9.40 per 1,000 were attacked, and 3.53 per 1,000 died from cholera. Consequently 2.5 times more Europeans than natives were attacked; the mortality per hundred of the attacks, however, was pretty much the same among both; among the former it was 33.69, whilst among the latter it was 35.50. The natives therefore seem to enjoy a relative immunity from cholera.

PETTENKOFER (same Conferenz), whilst opposing the views of Koch concerning immunity, is forced to admit that—



The (East) Indian is less predisposed to cholera than the European, as military experience has shown. But among the natives themselves there is a much greater difference. The Gurkas, who come from the upper part of India, which is not the endemic home of cholera, are just as susceptible as the Europeans. That I take from the history of Bryden.

BELLEW says: For the triennial periodicity of recurring cholera epidemics in India, I am not responsible. It is no invention of my own, nor do I pretend to offer an explanation of the phenomenon as such, but it is a fact plainly declared by the statistics of the disease in all parts of the country throughout the series of twenty years dealt with in this inquiry. (History of Cholera in India, London, 1885.)

TOMMASI-CRUDELI, in discussing the question of immunity from disease, in the conference upon the climate of Rome (1886), after having spoken of small-pox, thus expresses himself concerning cholera:

Another not less evident proof of it (immunity) is offered by cholera; for it may now be said that, when the economic and hygienic conditions of a population do not grow worse, the resistance of the human race towards cholera augments after each new epidemic.

Concerning immunity from cholera and other diseases, W. WATSON CHEYNE, of London, declares as the result of comparative inoculation experiments (British Medical Journal, July 31, 1886) that cultures in flesh-peptone-gelatine of proteus vulgaris are far more effective and pathogenic than those of the same organism in simple bouillon. He has also found that subcutaneous injections of these are less hurtful and powerful than those injections made directly into the muscular tissue. He has also discovered that the effect produced depends more or less intimately upon the dose injected. He also finds that relative immunity follows the inoculation. By keeping in mind this protective action, the feebler effect of the meat infusion cultures than the jelly cultures and the importance of the site of injection, the subsequent experiments have been almost absolutely constant. "The chief diversity which I found was in two experiments performed in Berlin, where a larger dose was necessary to kill an animal than I had found to be the case in London. These animals were, therefore, for some reason or other, more resistant than those experimented upon in London; possibly there might be some racial difference which accounts for the result." In speaking of what, to him, seems to be the legitimate application of his conclusions, he discusses the cholera question, and, while considering the difference between cholera and the more virulent attacks of cholera, he uses the following language: "Might not this to some extent depend upon the comparatively slow growth of diffusion of the bacilli, so that in the beginning of the epidemic only small doses are as a rule taken; these doses being insufficient for cases of virulent affection, but sufficient for cases of slight illness, which *may protect individuals, at least temporarily, from the fatal effect of larger doses?*" Mr. Cheyne's reported experiments comprised investigations concerning proteus vulgaris, bacillus anthracis, bacillus of mouse septicæmia (Koch), bacillus of chicken-cholera, bacillus of rabbit septicæmia, staphylococcus pyogenes aureus and albus, Sternberg's micrococcus, the tetanus bacillus, micrococcus-tetragenus. And that author found, contrary to his own preconceived notions and to the general belief of the medical world, that often a large dose of the micro-organisms is required to produce effect. In some of the organisms experimented with the fatal dose was infinitesimal (a single organism being sufficient to cause death), whilst with other organisms a larger dose was required to produce any effect, often running up into the millions. Another point insisted upon by this author is, that there is a great difference in the virulence of pathogenic power between cultures in gelatine and in bouillon, the latter being far less potent.

*IMMUNITY AFTER AN ATTACK OF CHOLERA—EXPERIENCE IN FRANCE, 1884.*

The Academy of Medicine of Paris directed a circular-letter of questions concerning cholera to the physicians of the localities infected by that disease in 1884, and in group L of general observations in that questionnaire is found the following: "Have there been observed recurrences among the people attacked, either in a former epidemic or in the present one? Give the results of this recurrence." In response to their questions, the Academy received 184 communications, but the committee appointed to analyze them eliminated 79; for various reasons given only 104 were used for analysis. Of this number, only 8 bore upon the particular question above mentioned, and it is reasonable to assume that the other 96 observers said nothing concerning this point because they had observed nothing bearing upon it. The results of this analysis may be stated as follows:

From Castelnau-dary, with a population of 10,000, we learn that there were 54 cases and 18 deaths from cholera, among which there was 1 recurrence; from Aix, with 20,257, number of cases unknown, deaths 117, among these 2 recurrences were observed, at intervals of 10 and 40 days; from Bézès, with 11,400 inhabitants, we learn of 124 cases and 40 deaths, among which were 2 recurrences; from Cette, with 35,000, the number of cases is not mentioned, but we learn that there were 92 deaths and 1 recurrence; from Nantes, with 124,300 inhabitants, we learn of 251 cases and 112 deaths, with 1 recurrence; from Perpignan, with 25,000 inhabitants, we hear of 325 cases and 225 deaths, and receive the indefinite statement that there were some fatal recurrences; from Pignans, population not stated, we learn of 22 attacks and 12 deaths, with 1 recurrence; from Cadenet, with a population of 26,000, we are not informed of the number of cases, but learned that there were 20 deaths and 2 recurrences.

*IMMUNITY AFTER AN ATTACK OF CHOLERA—EXPERIENCE IN SPAIN, 1885.*

While examining cholera in Spain, the writer prepared a circular containing a series of twenty-five questions relating especially to the nature, etiology, and prophylaxis of cholera, one of which requested the physician to state whether or not, in his own personal experience, he had observed a second or a third attack of cholera during the same epidemic, and in case of a positive reply to detail the symptoms and all the circumstances surrounding it. This circular-letter was addressed to some twenty-five hundred Spanish physicians located in the various cities, towns, and villages in that kingdom which had suffered from the epidemic. Among the large number of replies there were only eight in which a second attack was reported, and from an examination of the details of these there was no doubt left in our mind that six were not second genuine attacks after a complete recovery, but were in reality relapses due to imprudences of diet or otherwise before convalescence and complete recovery had been established. Two of the eight cases, from the details of the reports given, may have been genuine recurrent attacks of Asiatic cholera, or may have been simply seizures of cholera morbus (*cholera nostras*). It is well known that after an attack of Asiatic cholera the digestive apparatus is left in a damaged condition, and disorders of the intestines continue for a long time. The habits of life and the imprudences so common to the class of people most frequently suffering from Asiatic cholera in that country are such as to render them more than usually liable to suffer attacks of *cholera nostras*. As having an important bearing upon this suggestion, the writer made an analysis of the vital statistics of Spain, covering the five years previous to 1885, for the purpose of learning the extent of prevalence of *cholera nostras* among that population, and the result of the inquiry shows that the number of deaths attributed to that disease averaged per year sixteen per every million inhabitants.



## SECTION 2.

## PERIODICITY OF CHOLERA EPIDEMICS RELATED TO IMMUNITY.

*PERIODICITY OF CHOLERA EPIDEMICS IN INDIA SUGGESTIVE OF IMMUNITY.*

Illustrations Nos. 22-33 are graphic representations of the results of analysis of the prevalence of cholera during a long series of years in the various provinces of Hindostan and Burmah.

These charts, deduced from the official statistics concerning cholera in India contained in the sanitary reports of that Government, show the marked periodicity of occurrences of the disease after periods of decided cessation of two to five years. This peculiarity is especially striking in the charts relating to those provinces situated outside of the area of so-called endemic prevalence of cholera.

Illustrations Nos. 34-37 represent graphically the presence of small-pox in the presidencies of Bengal, Bombay, and Madras, and in the city of Calcutta.

These charts are very similar in outline to those relating to cholera, and show also a decided periodical occurrence of the epidemics after decided periods of cessation, of a slightly longer duration, however, than in the case of cholera.

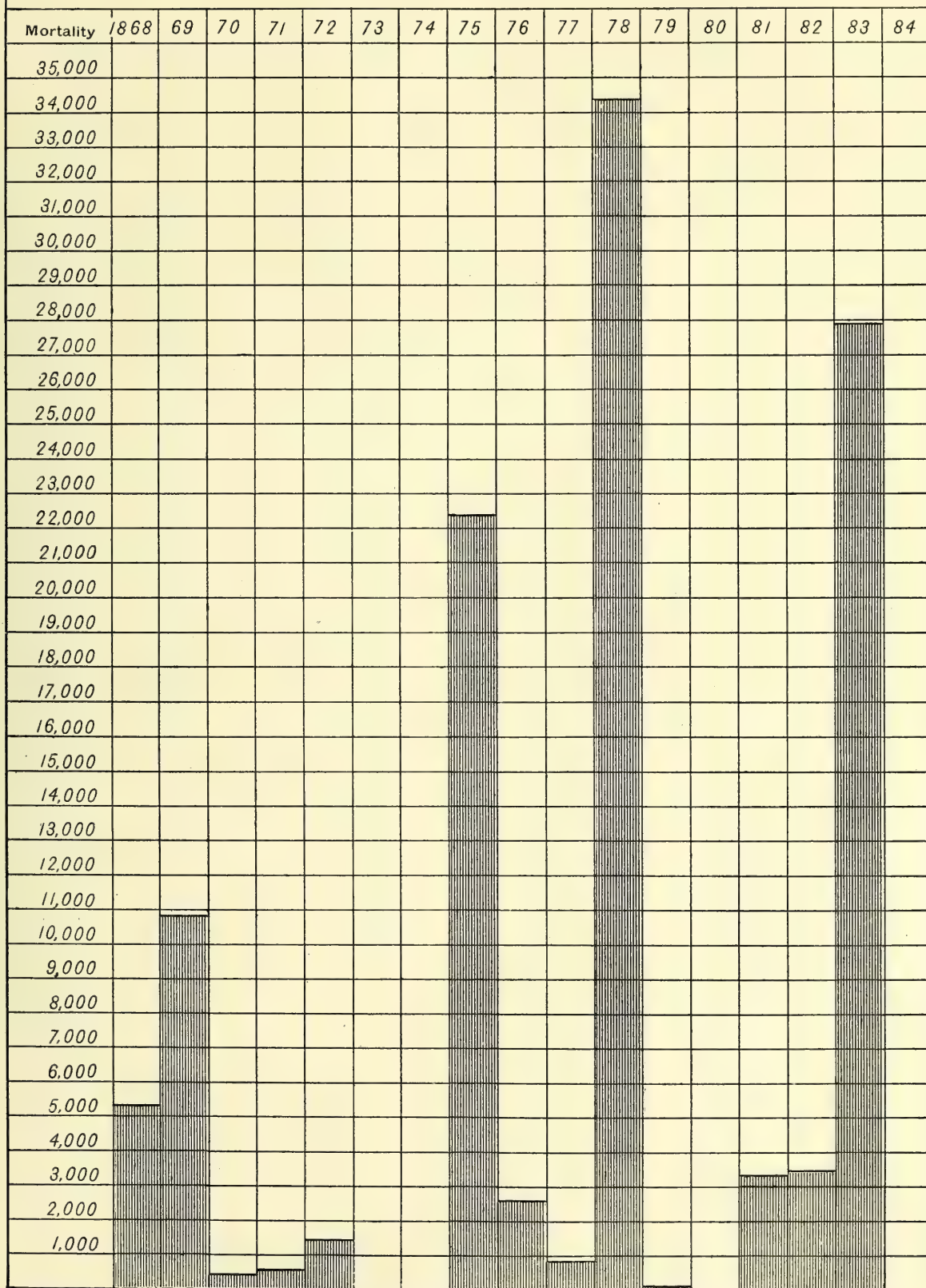
As already stated (quotation from Bellew), the course of cholera in India has a marked periodicity outside of its endemic area. In some respects the course of cholera in that country is peculiar, as compared to its travels over other parts of the world, and as compared also even with its progress through some portions of western Hindostan. I refer to the curious fact—made such a prominent feature in some of the writings of East Indian authorities, and observed so constantly—that epidemics of cholera seem never to travel down the river Ganges or the Brahmaputra towards the endemic area in lower Bengal, but that the invariable progress of the disease is up-stream and towards the northwest. So constant is this course of cholera in that portion of the country that it forms the basis for the direction of hygienic measures against cholera among the troops in various parts of India, and forms a basis also for the belief entertained by many of the Indian health officers in the non-transmissibility of cholera by means of flowing water.

At intervals varying from two to four years, cholera epidemics spread from the endemic area in certain usual directions. They go towards the northwest, then turn westward, and later southwestward, and sometimes finally, after reaching the presidency of Bombay on the Indian Ocean, turn southward and southeast to reach Madras. It often happens, however, that Madras is reached by another course, the epidemic progressing towards this province sometimes by proceeding down along the coast from Orissa, the extreme southwestern district of Bengal, and sometimes working its way southward from the central provinces. This is almost the universal course of the progress of epidemic cholera in India. Within the endemic area the periodicity of cholera is but little marked. In fact within this area great epidemics are rare. At certain more or less irregularly recurring periods the disease there becomes more prevalent, as the general vital statistics for the province of lower Bengal show, but this increased prevalence is due to an increased number of scattered and more or less isolated cases rather than to the occurrence of a genuine epidemic. Outside of this area, however, the epidemics of cholera have a marked periodical type. After a population outside of the endemic area has been severely ravaged by cholera one year, there is almost invariably a period of marked freedom from epidemics, varying from three to five years.

This periodical type of the prevalence of cholera in India is very clearly indicated by the accompanying charts constructed from the cholera mortality, during many years, as recorded in the annual sanitary reports of the various provinces. There seems to be, however, one circumstance which interrupts the regularity with which epidemic cholera prevails at stated periods. I refer to the prevalence of famine. The usual course of the epidemic is markedly modified during the years when famine has been extensive, the existence of famine always greatly increasing the recorded prevalence of cholera, as will be seen by reference to the accompanying charts.

## CHOLERA PREVALENCE.

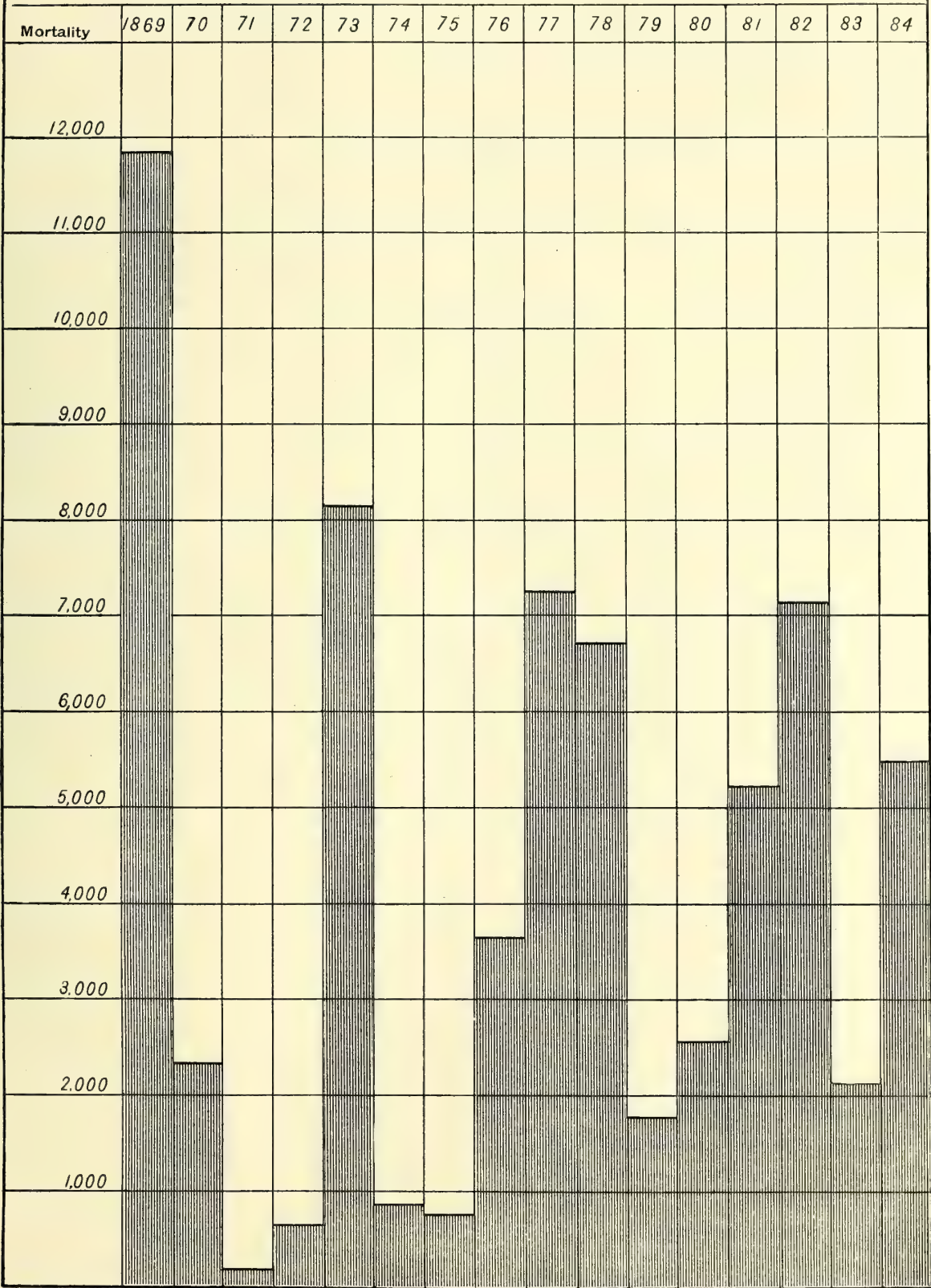
PROVINCE OF BERAR.







CHOLERA PREVALENCE.  
PROVINCE BURMA.

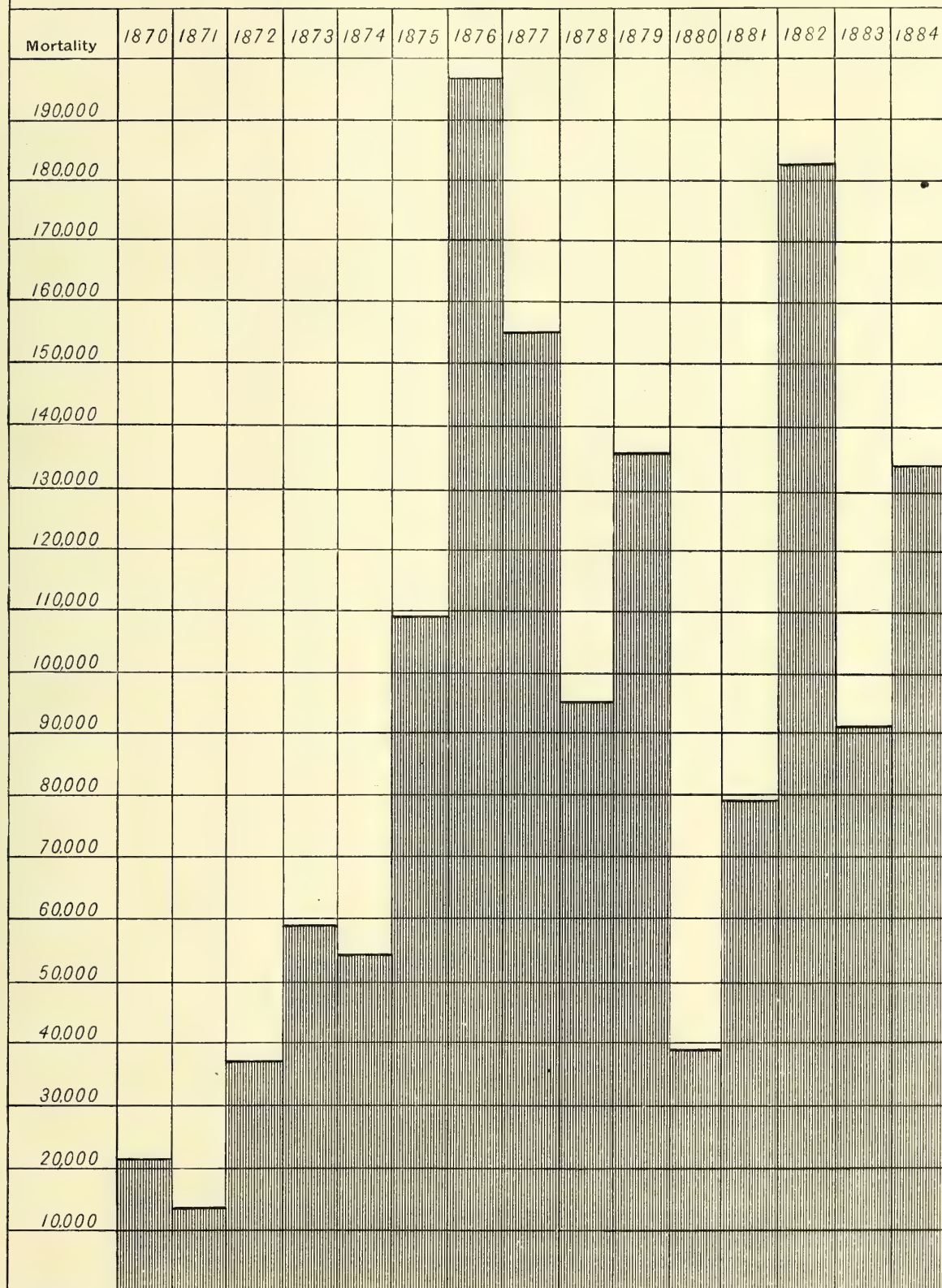






No. 24.

# CHOLERA PREVALENCE. PROVINCE OF BENGAL. (CALCUTTA EXCLUDED.)

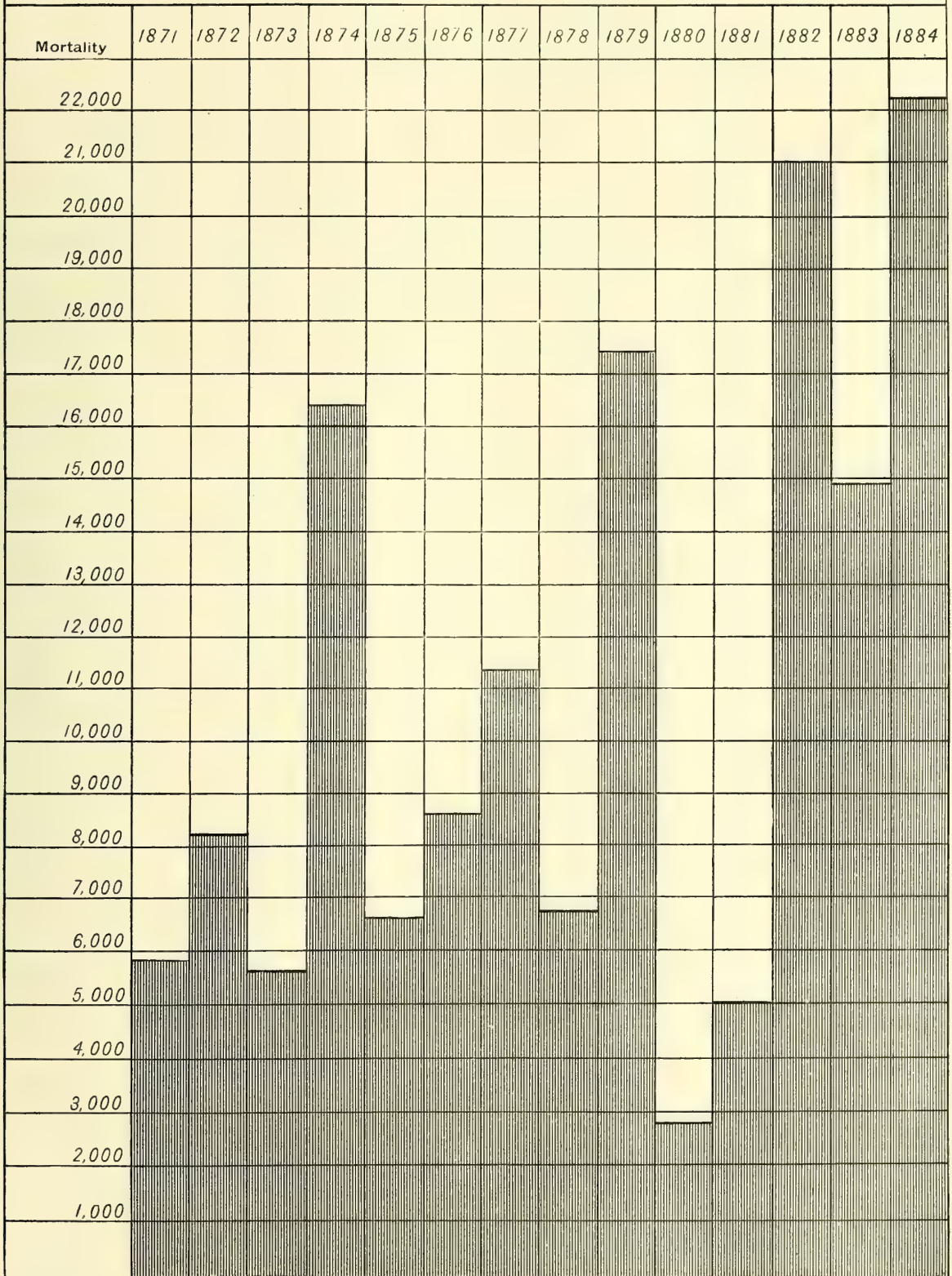






No. 25.

CHOLERA PREVALENCE.  
PROVINCE ASSAM.



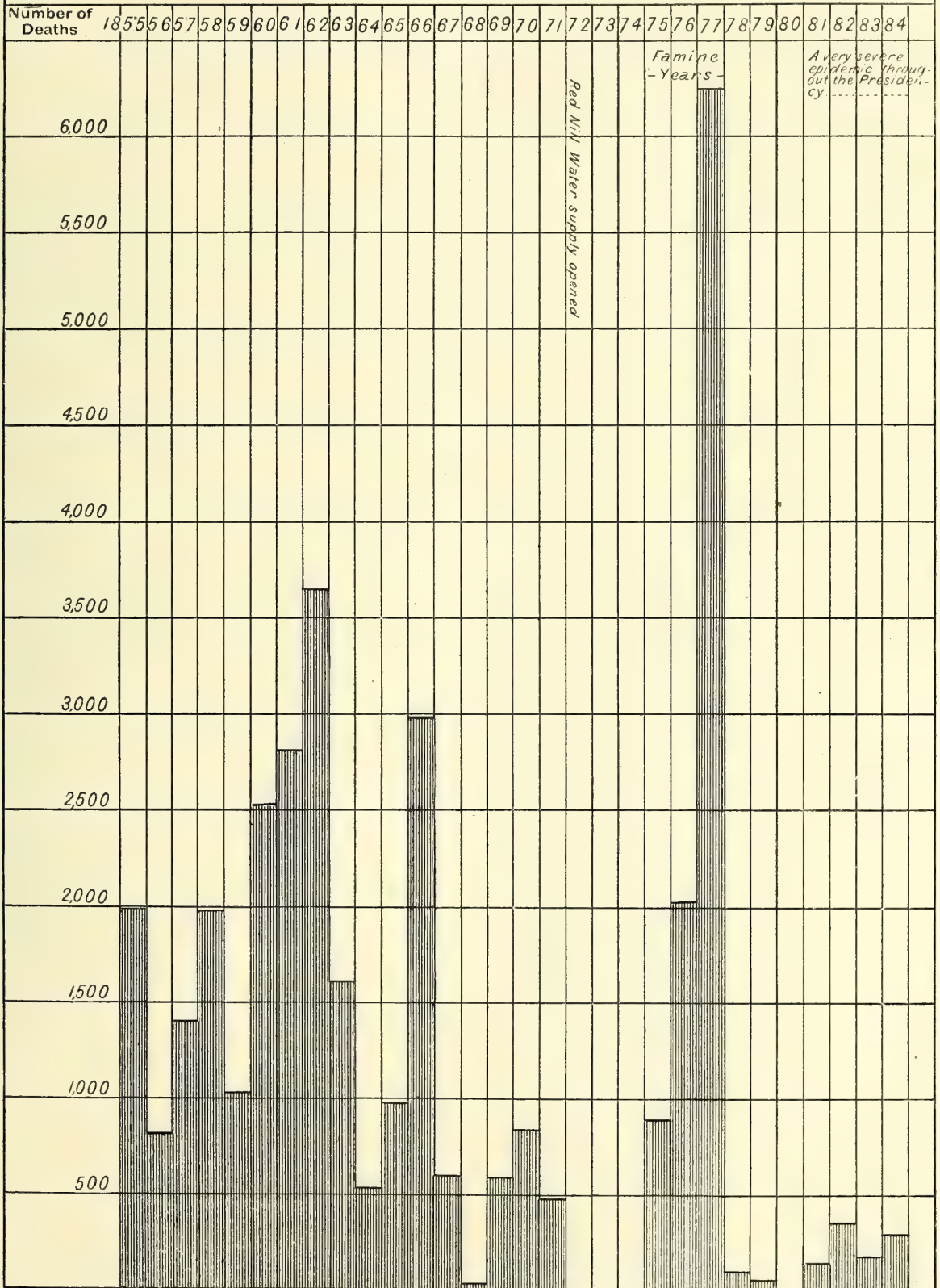
G. Marx del.





No. 26.

DEATH FROM CHOLERA IN THE CITY OF MADRAS.



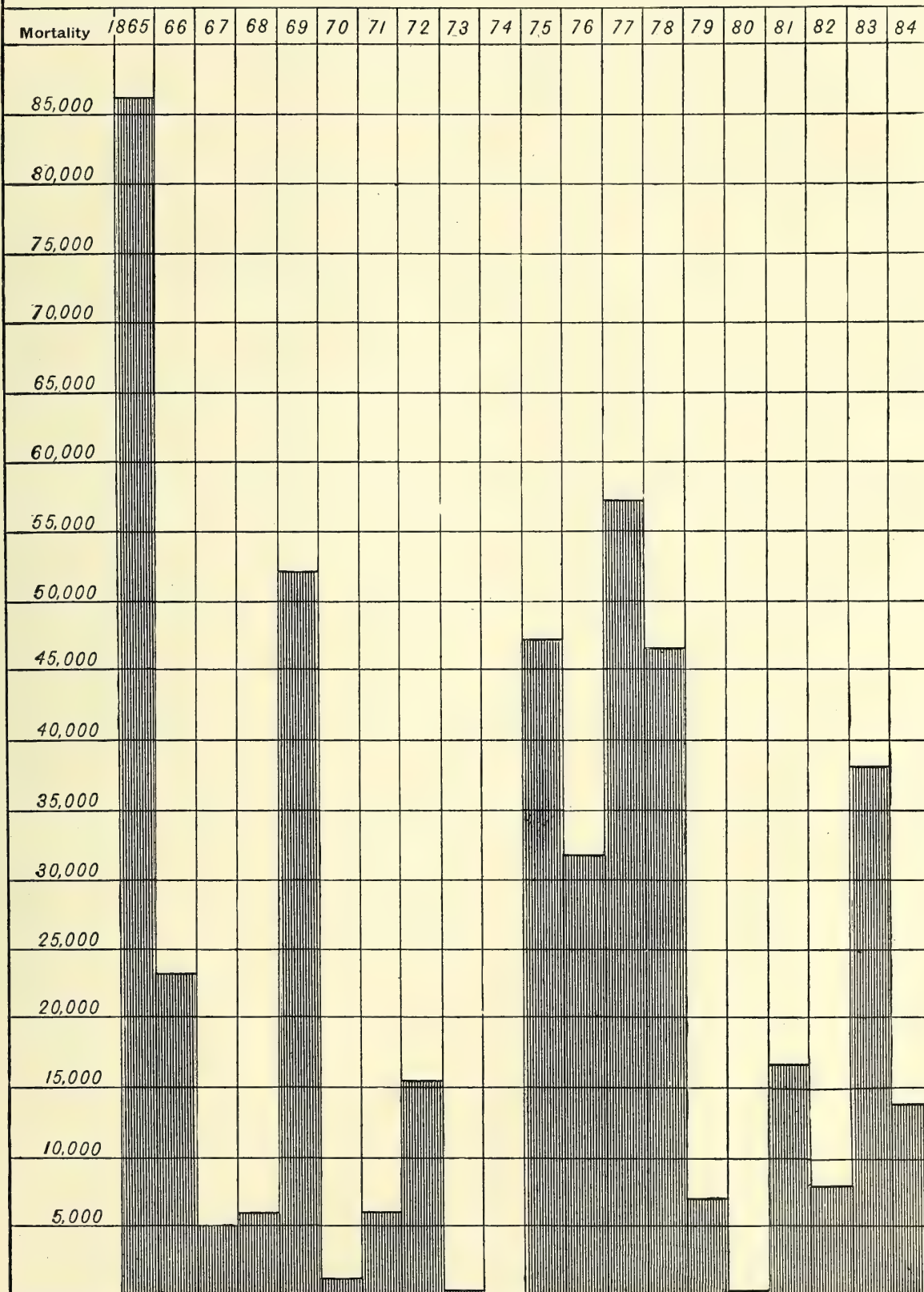




No. 27.

# CHOLERA PREVALENCE.

PROVINCE OF BOMBAY.



G. Mark del.

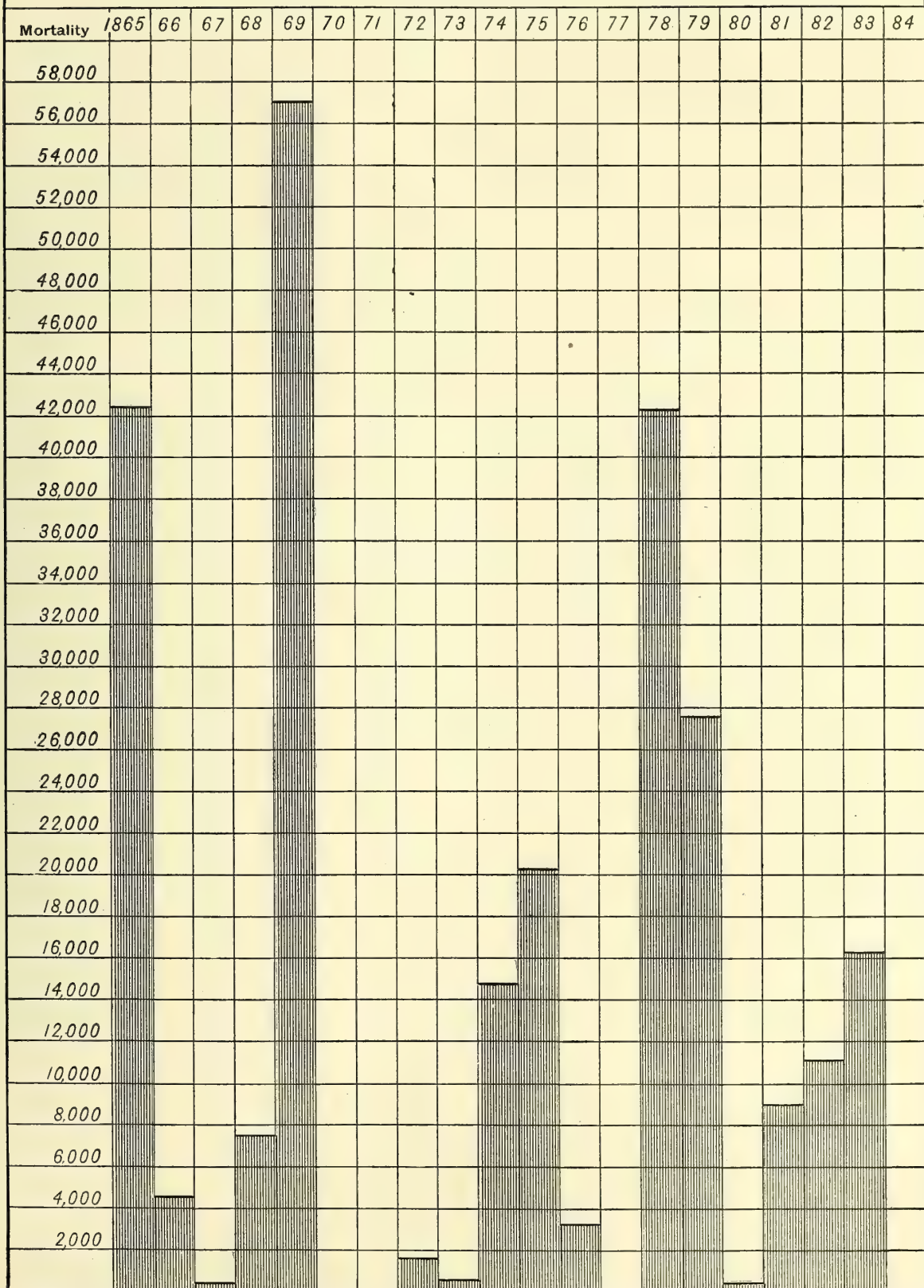




No. 28.

# CHOLERA PREVALENCE.

CENTRAL PROVINCES.



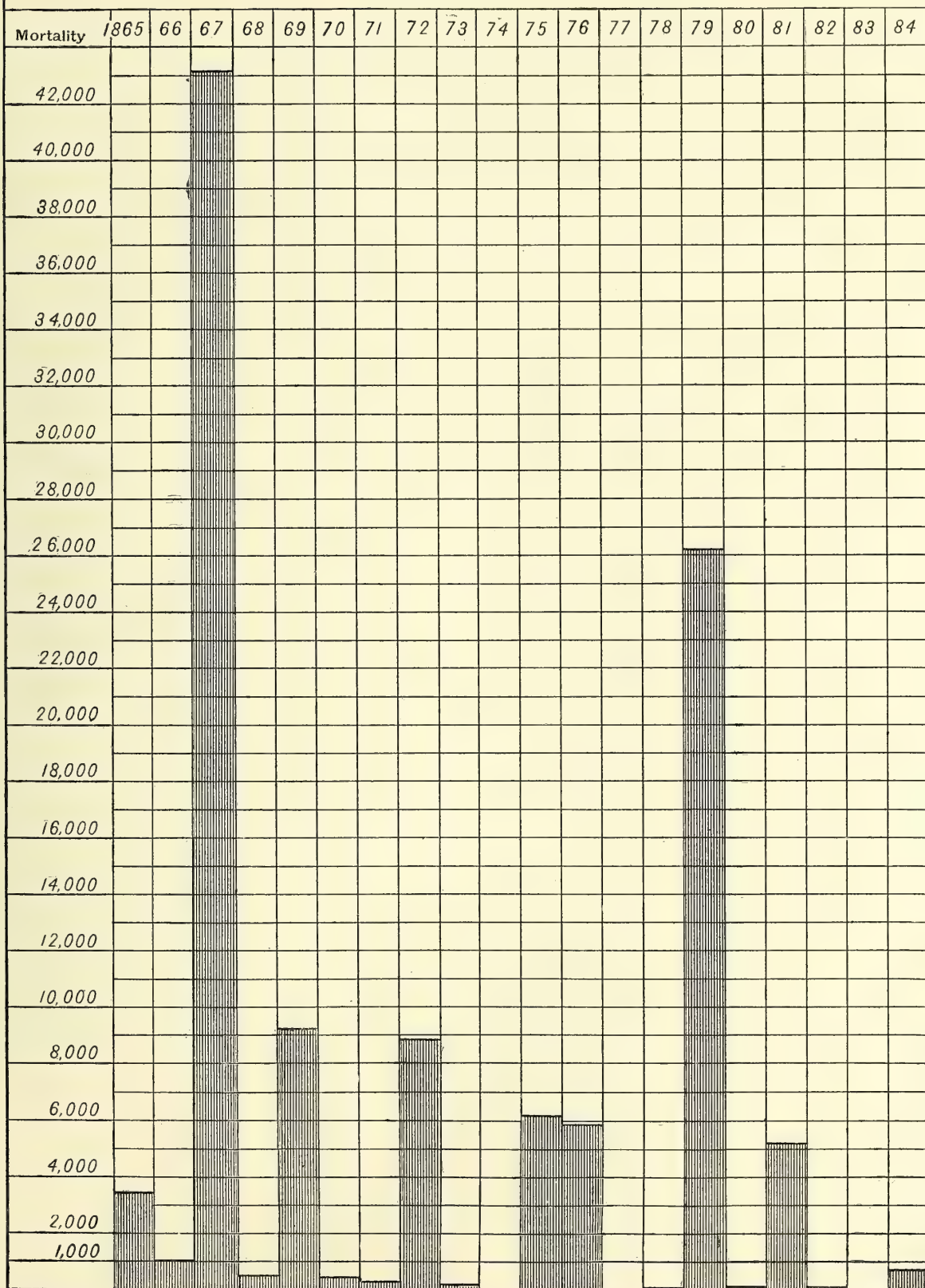




No. 29.

# CHOLERA PREVALENCE.

PROVINCE PUNJAB.

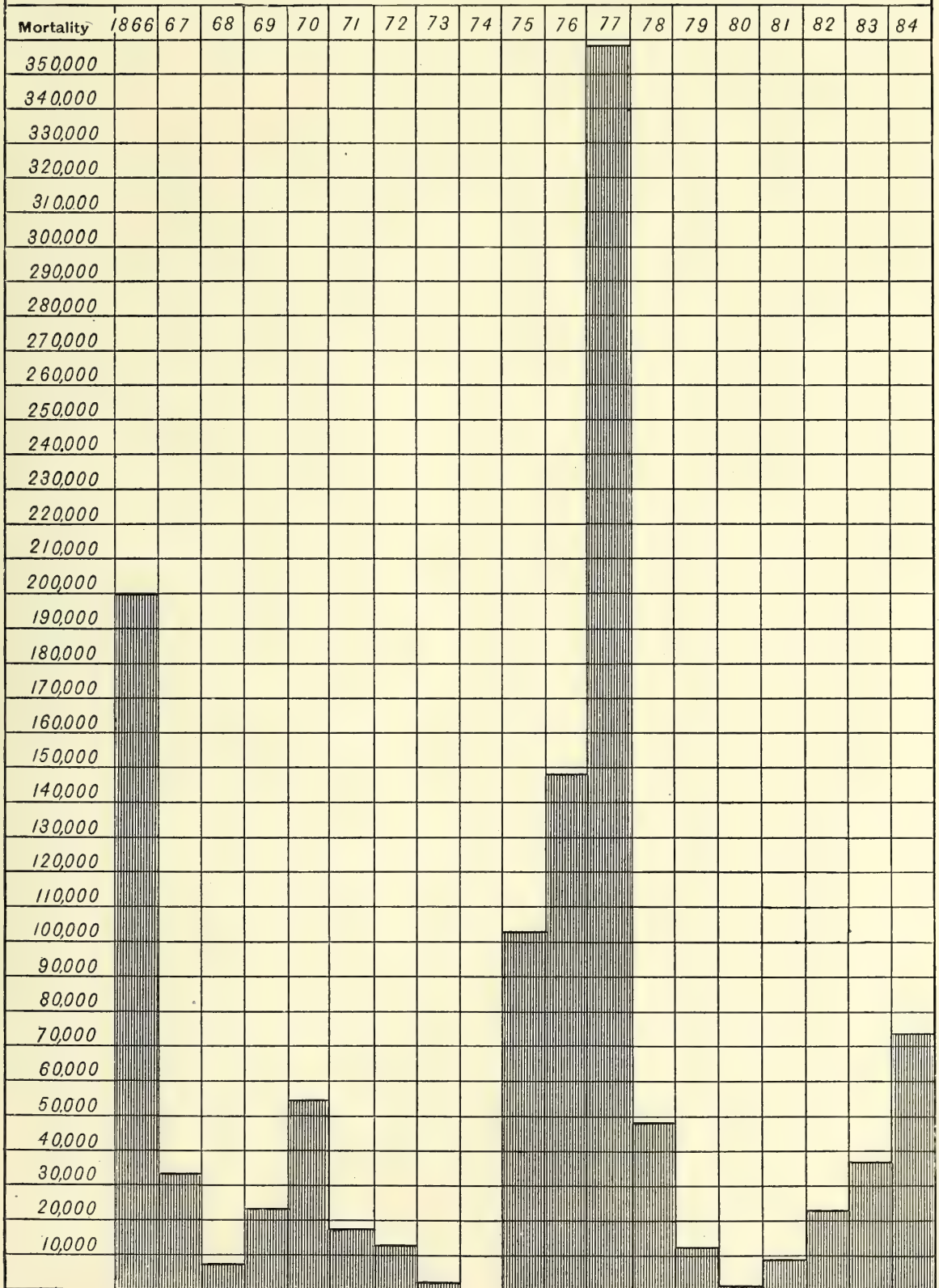






No. 30.

# CHOLERA PREVALENCE. PROVINCE MADRAS.



G Marx del.

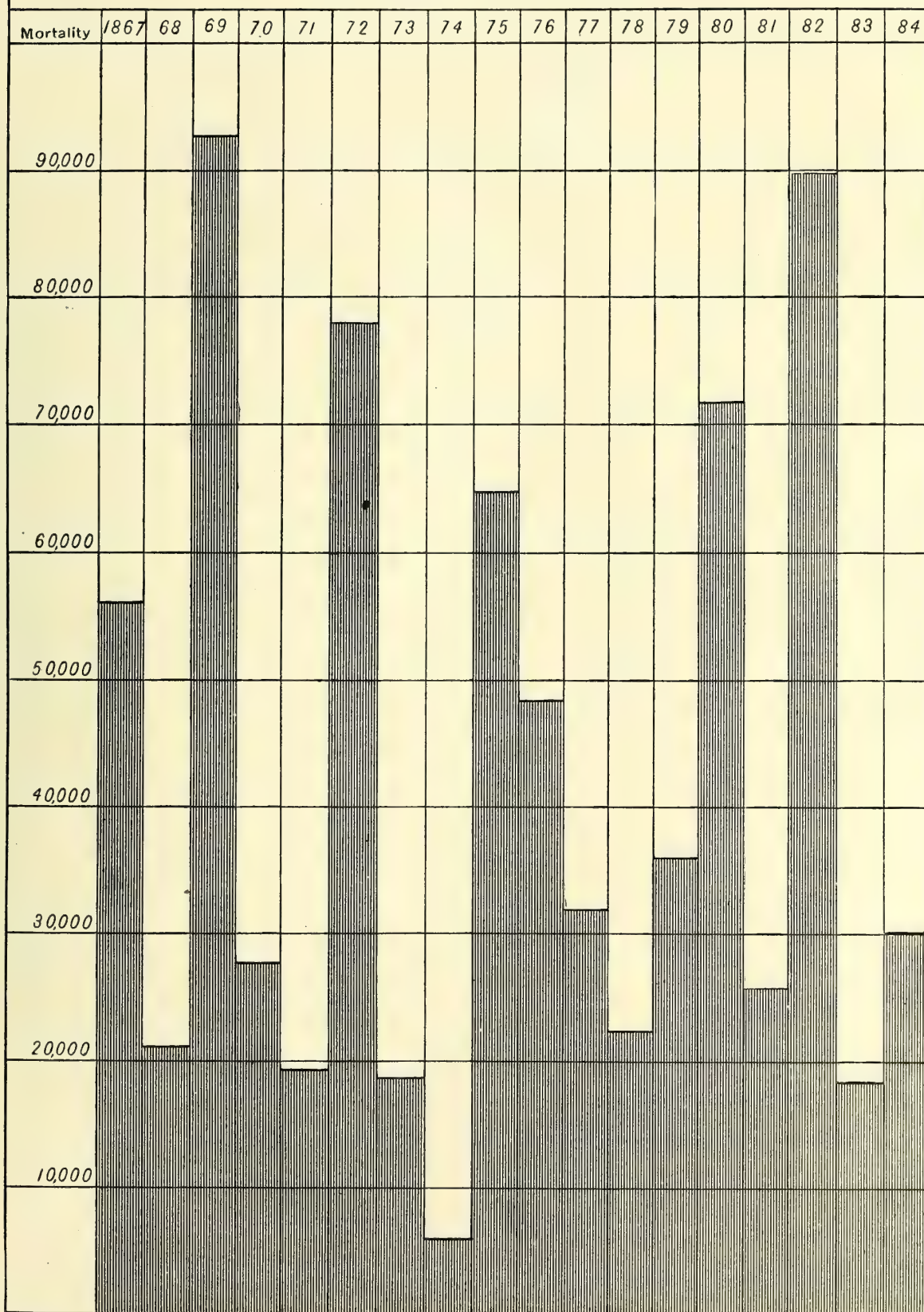




No. 31.

# CHOLERA PREVALENCE.

NORTH WESTERN PROVINCES AND AUDH.

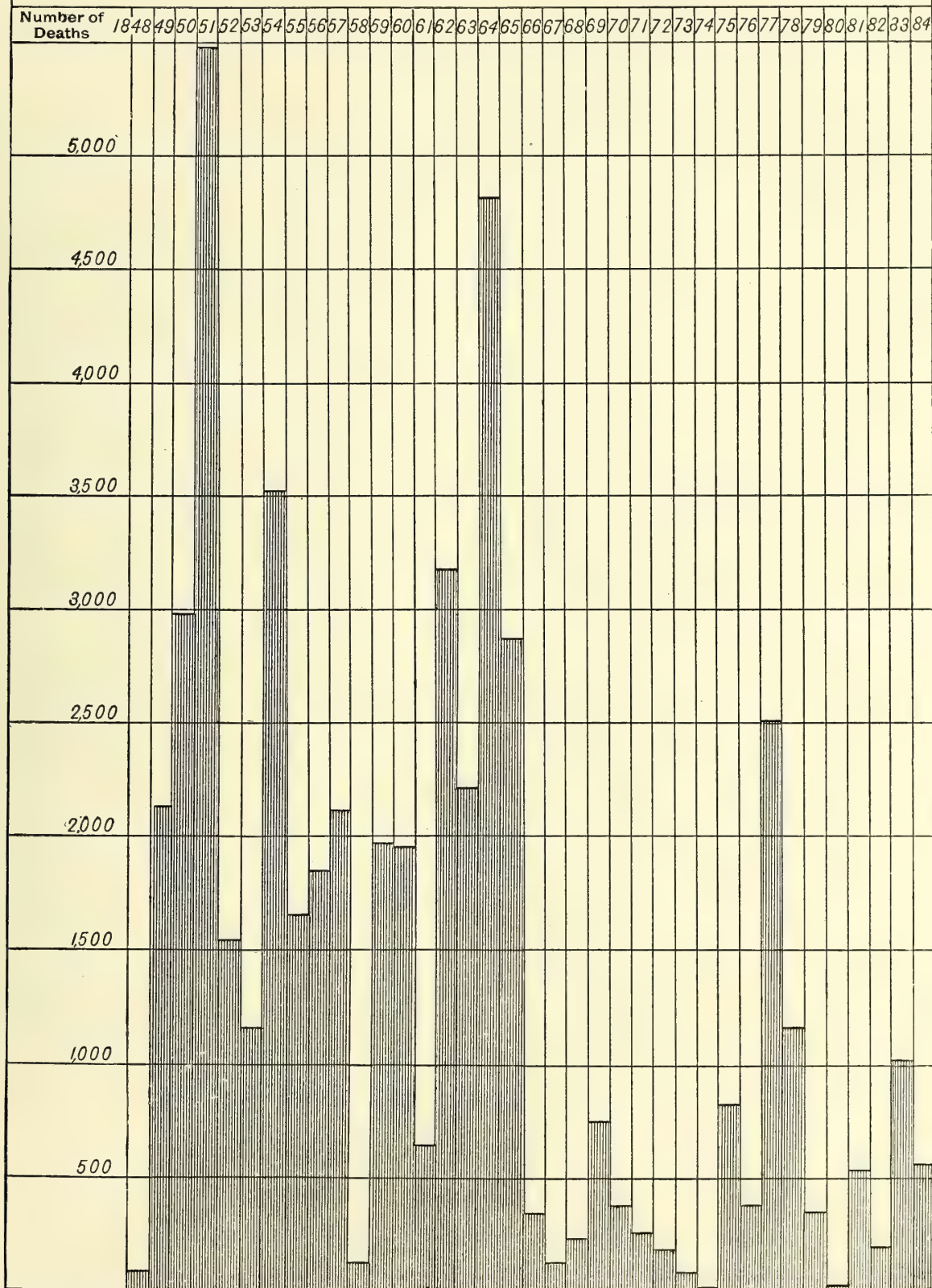


G. Marx del.





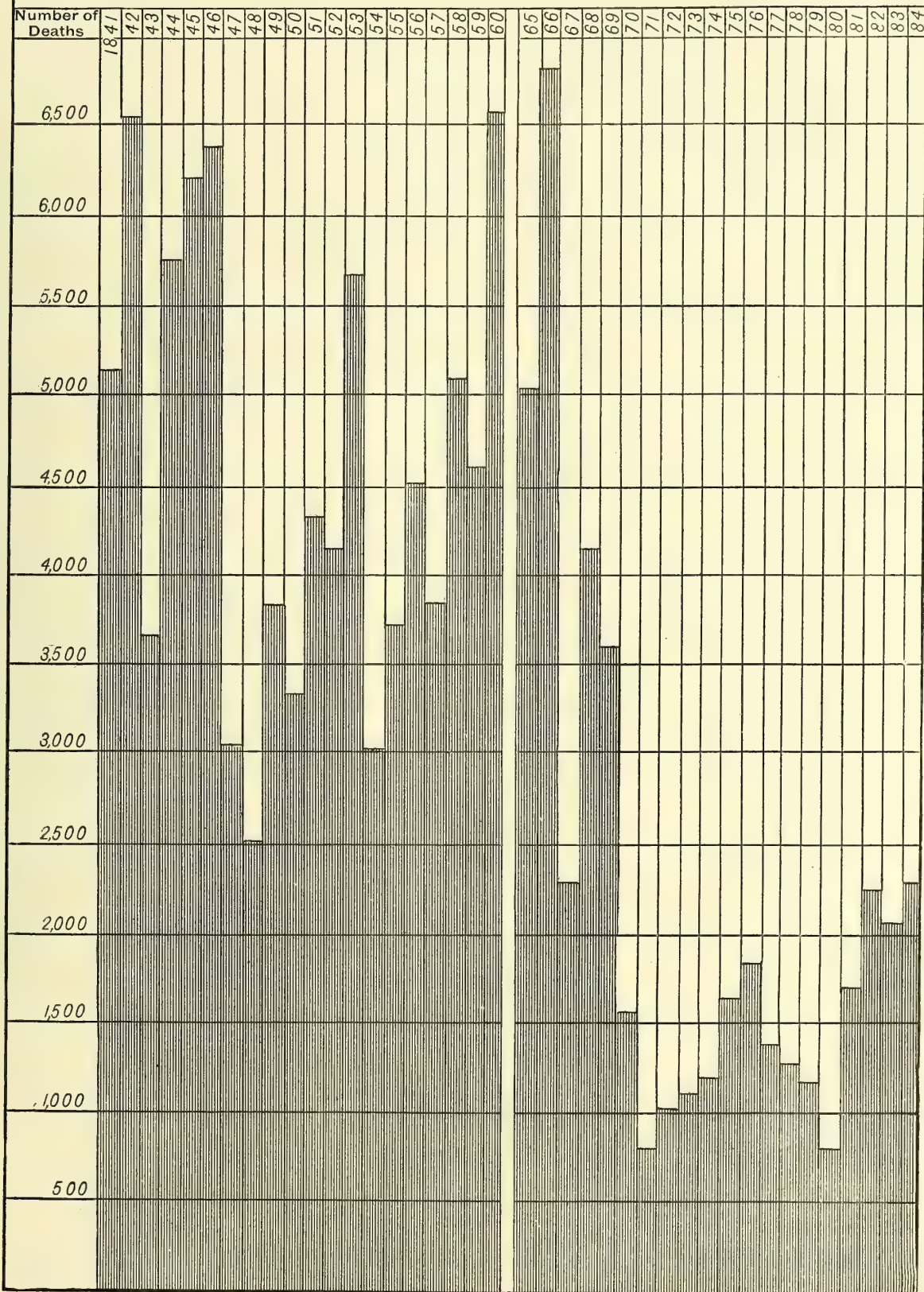
DEATHS FROM CHOLERA IN THE CITY OF BOMBAY.







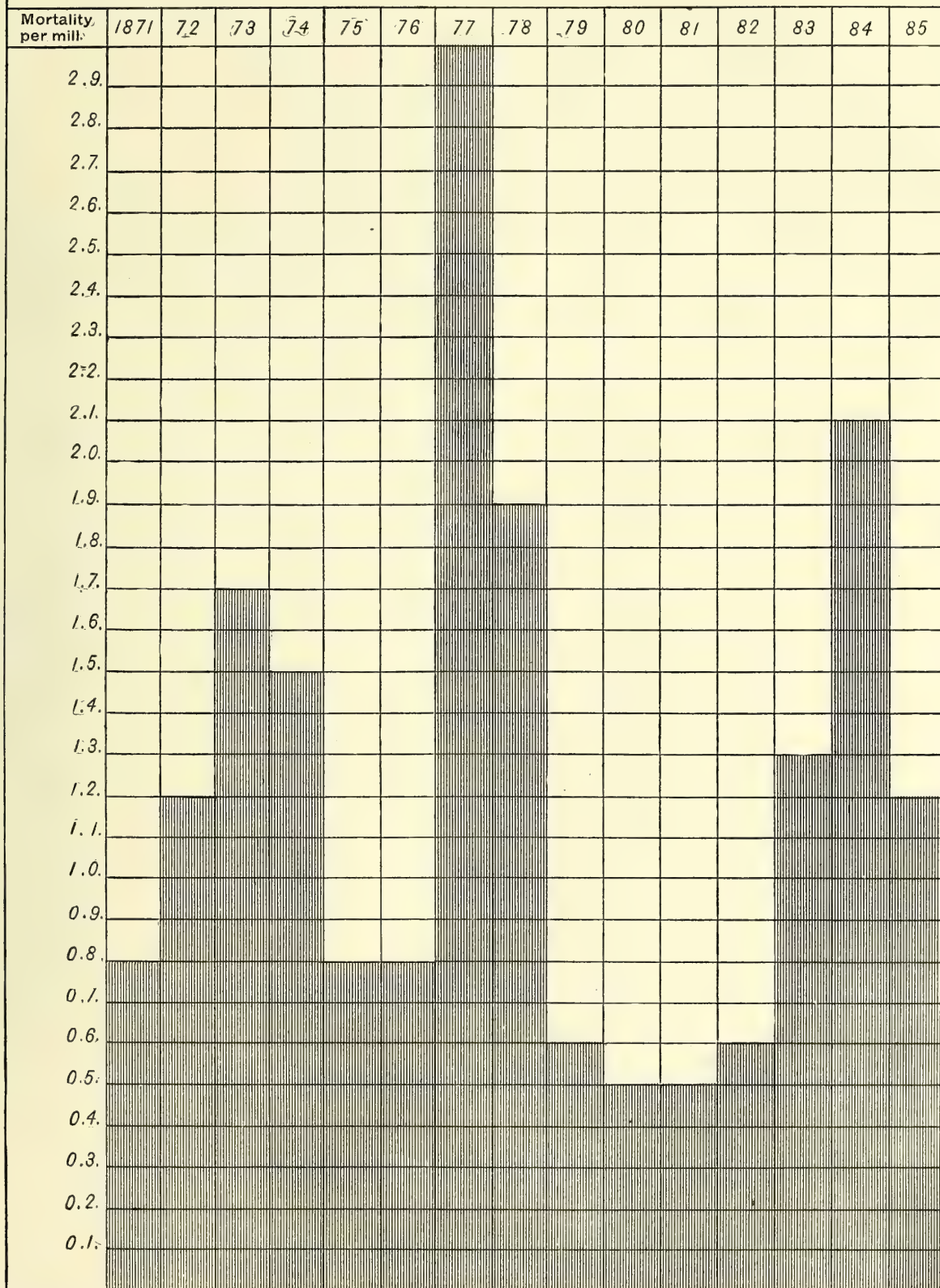
## DEATHS FROM CHOLERA IN THE TOWN OF CALCUTTA.







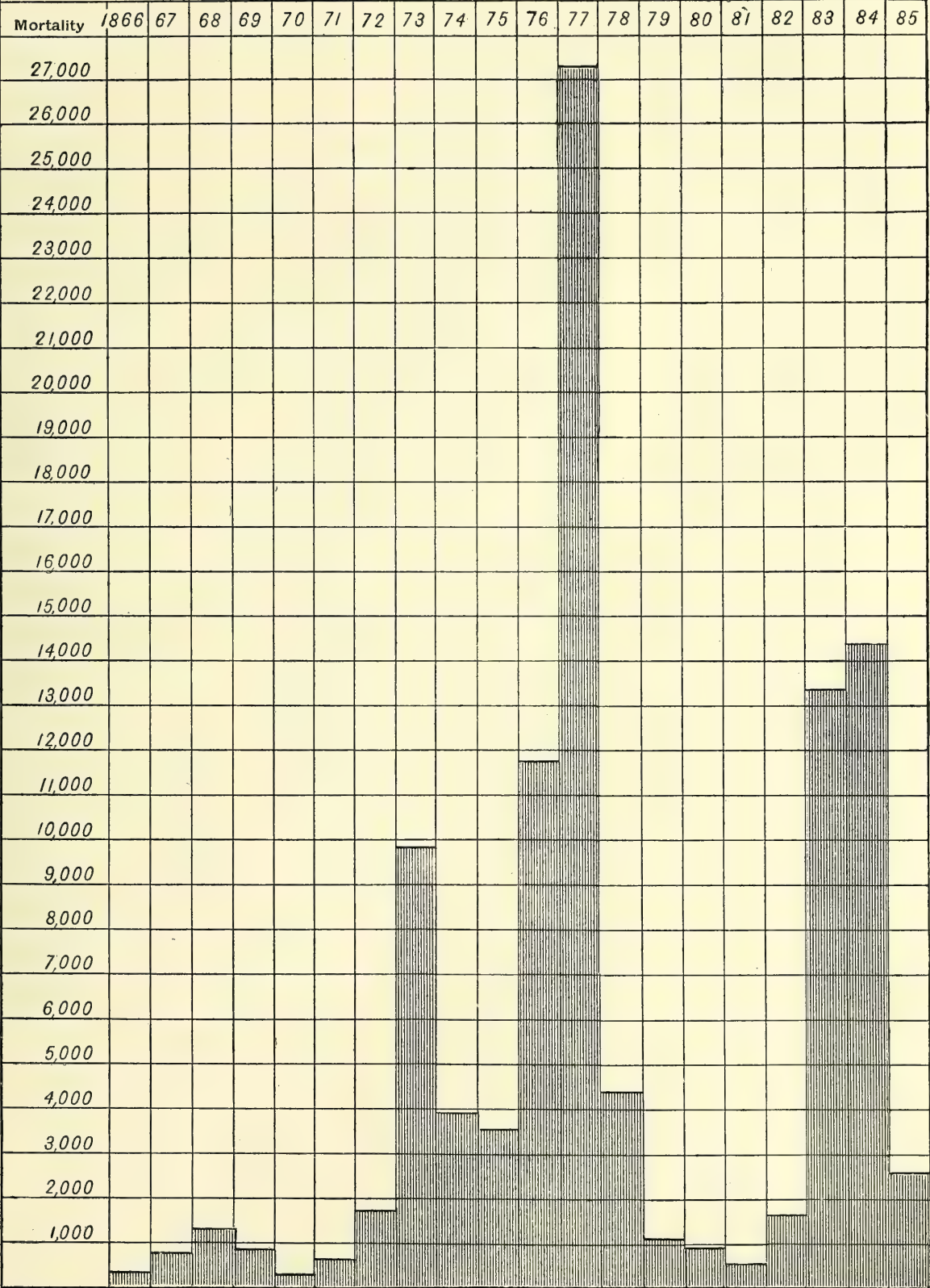
SMALLPOX PREVALENCE,  
Per 1000 of Population,  
MADRAS PRESIDENCY.





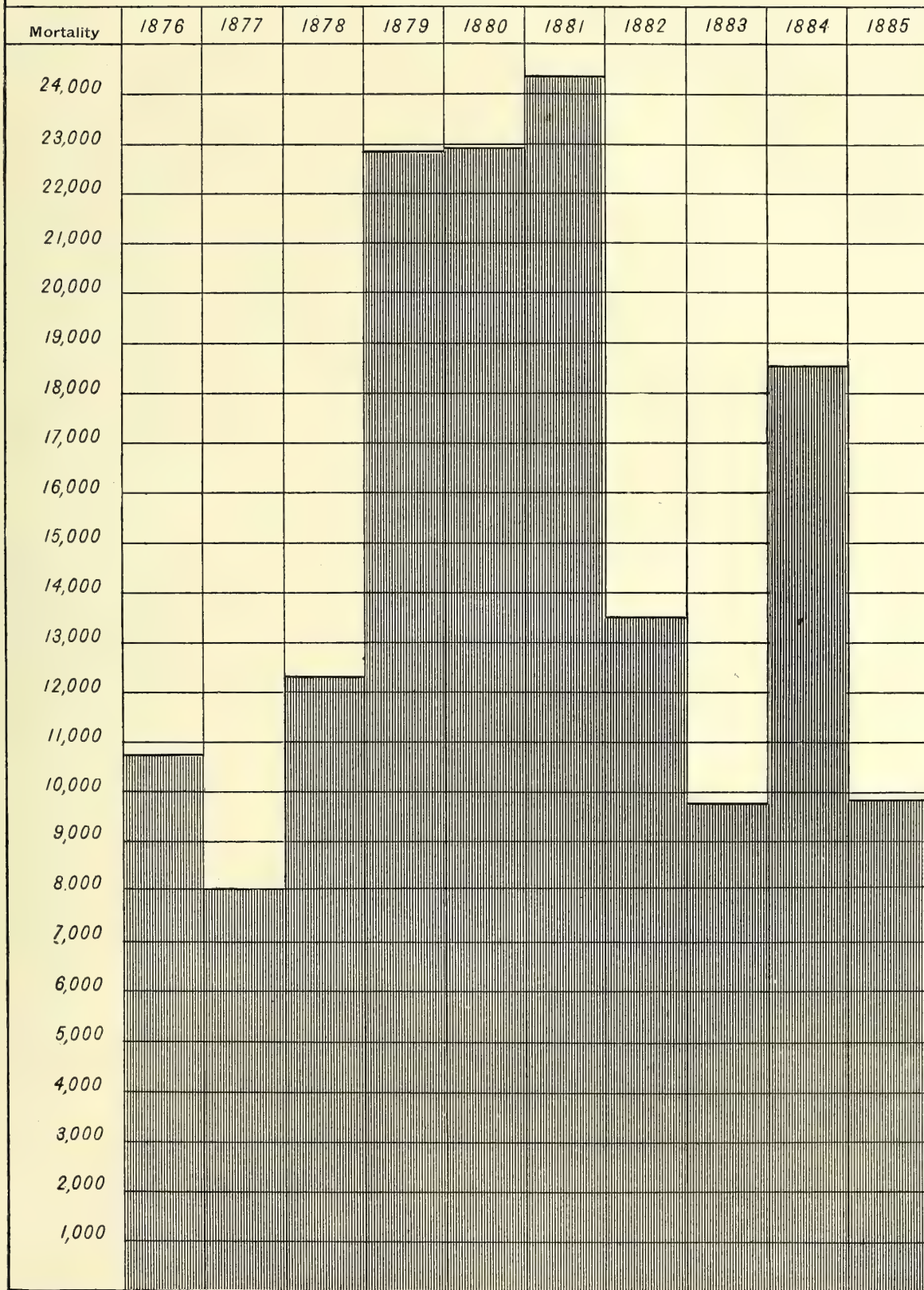


SMALLPOX PREVALENCE.  
BOMBAY PRESIDENCY.







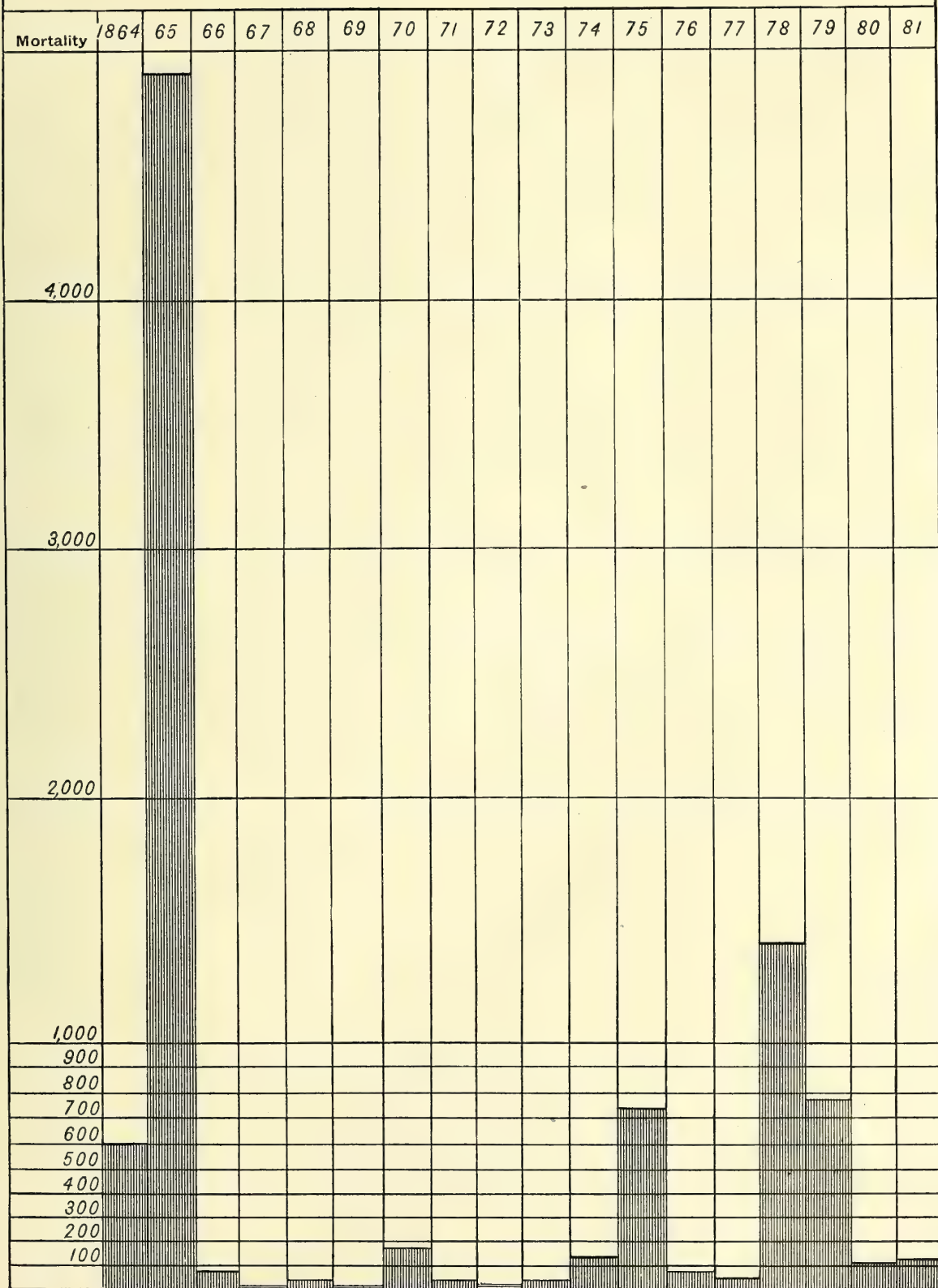
SMALLPOX PREVALENCE.  
BENGAL.





No. 37.

# SMALLPOX PREVALENCE. CALCUTTA.







I have spoken of the presidency of Bengal as the area within which cholera is endemic in India. In this connection I would call attention to the history of cholera in the province of Assam, which is located along the valley of the Brahmaputra at the base of the Himalayas, on the eastern border of the presidency of Bengal. On the one hand, the cholera epidemics of Assam have been attributed by some writers to the introduction of the disease from lower Bengal by the coolie laborers, transported upon the river boats. On the other hand, writers have positively denied this relation of cholera in Assam to the transported coolies, some of the most positive denials being based upon the fact, which seems to be substantiated, that cholera was endemic in certain sections of the province of Assam before the introduction of coolie labor began. From the reports of some of the early sanitary commissioners of that province it appears that the disease has been more or less prevalent there from year to year; in fact, it seems that the only time when the disease has not existed somewhere within the province has been during the annual periods of inundations of the Brahmaputra, converting the valley for a period of from two to three months into an inland archipelago, the islands being the villages located upon the higher ground, and the means of intercommunication being boats. According to these statements it seems the cholera constantly appears in villages scattered all over the province immediately after the subsidence of the waters, often being most extensive in districts where the river boats transporting coolies never touch. By reference to the chart of the cholera mortality for the province of Assam a similarity is noticeable between that and charts for the presidency of Bengal, where cholera is admittedly endemic. And just here I would point out an apparent difference between the charts for provinces in which cholera is only epidemic and the charts of annual cholera mortality in Bengal.

Thus the cholera charts for the provinces outside of the endemic area of the disease strikingly show that a year of marked prevalence of cholera is usually followed by another in which the disease has greatly lessened, to be followed still by a third, and sometimes a fourth, during which the disease is almost if not entirely absent; after this period of subsidence again comes a year of greatly increased prevalence, to be followed again by a period of subsidence, and so on. On the other hand, a glance at the chart for the province of Bengal shows a marked contrast. During the years 1870 to 1884, inclusive, the following seems to have been the course of the disease in that province: In 1870 there was a marked rise in the number of cases of cholera, followed the next year by a slight subsidence. In 1872 there was a considerable rise, and in 1873 a still greater rise in the number of deaths; in the next year a slight subsidence, and in the following year a very considerable rise again, followed still by another year (1876) of great increase of cholera. The next year there was a decided subsidence, and still the next year a further subsidence, when again in 1879 there was a marked rise, followed the next year by a marked fall, and the year after by a rise again, and the year after that (1882) still another increase in the number of deaths from cholera; the following year was marked by a considerable subsidence, and the next year by a considerable increase. This peculiarity of the cholera in the endemic area is in the main identical with that indicated for the province of Assam, in the accompanying chart.

Reference has been made in some of the foregoing pages, while discussing the question of immunity following individual attacks of epidemic cholera, to similarities in the periodical recurrences of epidemics of cholera and of epidemic contagious diseases which unquestionably leave after them a more or less lasting immunity from further attack; and I have associated here with this collection of cholera charts a few charts constructed from the official statistics of small-pox mortality in several provinces of India. It will be noticed that with regard to periodicity and recurrence of epidemics they are very similar in their general features with those of epidemic cholera, the period of recurrence, however, appearing to be somewhat longer.

The analysis of the statistics of cholera in India, covering a period of thirty or forty years, which the writer has made, and represented in the accompanying graphic charts, seems to indicate, by the periodical occurrences of epidemics, the existence of immunity of localities for terms more or less regular in duration, especially in those portions of Hindostan outside of those areas where the disease is endemic, viz, in Bengal and Assam. It will be



seen also that the periodical recurrences of cholera in that country bear a striking resemblance to those of small-pox, the immunity seeming to be more or less positive for two to five years. In the examination of these charts it should be noted that the years of famine in that country, in which cholera is always more fatal, have occasionally interfered with the regularity of the periods.

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*PROOF OF IMMUNITY AND RARE RECURRENCES NOT ANTAGONISTIC.*

The occasional existence of second attacks of cholera even during the same epidemic can not, in view of our experience concerning second attacks in diseases which are well known to confer immunity as a rule, be looked upon as indisputable proof of the non-existence of such an immunity after an attack of cholera; in fact, it is to be expected that in cholera, as in all other infectious diseases such as small-pox, measles, scarlet fever, etc., genuine second attacks may occur. In this connection the writer took occasion to collect, through the kindness of his friends, Dr. J. M. Keating and Dr. William Edwards, of Philadelphia, some examples of unusually early recurrences of measles and small-pox after a first attack. Were the literature of medicine exhaustively searched and the unpublished experiences of the private practitioner collected, undoubtedly not infrequent examples of early second attacks of these and other diseases of similar character would often be found. The result of a short search above referred to made by Drs. Keating and Edwards is introduced below.

Furthermore, the experiences of investigators in experimental pathology with especial reference to the causation and prevention of infectious diseases in animals has brought to light the indisputable fact that the duration of immunity in the case of several infectious diseases is a variable though none the less appreciable quantity. In some diseases it may not last over two or three years, whilst in others the period of immunity may persist for a decade or more. Whilst it appears to be a positive fact, although heretofore unappreciated by the vast majority of medical practitioners, that second attacks of cholera during the continuance of the same epidemic in a locality are of extreme rarity, instances of an individual suffering from cholera during one epidemic, attacked a second time years after, appear to be far more numerous; yet even these cases are undoubtedly apparently rare. The whole evidence upon this point appears to justify the deduction that *one attack of Asiatic cholera confers upon the individual at least a short immunity from a second attack, and for the purposes of prophylaxis the value of this fact should not be underestimated*, for it is possible that it may serve as a basis for the most efficient means of promptly stamping out a local epidemic of cholera after it has once become firmly rooted, and at slight cost or inconvenience in comparison to measures popularly practiced at the present time, such as maritime and land quarantines, sanitary cordons, etc. The existence of a period of immunity, whether long or short, following an attack of cholera once established, would, in the light of the knowledge of prophylaxis acquired in recent years through investigations concerning preventive inoculation, seem to furnish scientific warrant for efforts in this direction in order to find a trusty and practicable vaccine for Asiatic cholera.

*SHORT INTERVALS OF RECURRENCE OF SCARLATINA AND MEASLES.*

No. 1504 WALNUT STREET, PHILADELPHIA, *February 15, 1887.*

MY DEAR DR. SHAKESPEARE: As I understand your request, it is that I should give you a few references that bear upon recurrent attacks of the zymotic diseases in childhood.

For this purpose I send you a table which, though very incomplete, I hope will be of some service to you.

I may say that while, as a rule, all the zymotic diseases protect from recurrent attacks, or at least have a tendency to lessen the severity of these recurrences, the exceptions which prove the rule occur very frequently and in each disease.

In my table I have *not* included the relapses, which are most frequent in typhoid fever, but I have only mentioned those attacks that have been followed by a restoration to health, and in which after a shorter or longer period of time there has been a recurrence of the disease. Measles present this peculiarity oftener than any of the others, but it is by no means uncommon in variola, scarlet fever, and whooping cough.

I do not class typhoid fever and diphtheria among these affections.

Yours, sincerely,

J. M. KEATING.

*Table showing the interval of recurrence of Scarlatina and Measles.*

[Compiled by Dr. J. M. Keating, of Philadelphia.]

Observer's name.	Reference.	Remarks.
Thomas Hillier...	Diseases of children, p. 301, (1868).	Scarlatina: recurrence of this disease within a month of its first occurrence is not very rare. A student under the author's notice had contracted scarlatina three times and that a week after the third attack he had a distinct recurrence. Dr. Richardson states that he himself has had three distinct attacks of scarlatina. The author has seen a young woman in the Sever hospital suffering from a second attack of scarlatina, the first attack having occurred five weeks previously. In both seizures, the rash, the throat and other symptoms were quite characteristic.
Thomas.....	Ziemssen Cyclop. Pract. Med., Vol. II, p. 190.	Scarlatina: West ascertained the interval of recurrence in one case to be thirty-six days. Laudette put it at two months; Holst and Wetzler at three months; Salzman at five months; Easton and Wajanowsky at six months, the latter at nine; Billing at ten; Cohen and Webster, the latter in two cases at eleven months; Brown, Henoch. Thomson, Vogt, Wetzler (two cases), Trojanowsky fixed it at one year, the latter at one and a half years; Salzman at fourteen months; O'Connor, Trojanowsky (two cases) and Thomas at two years; Salzman at two and two-third years; Salzman, Thomson, Trojanowsky in four cases at three years, the latter in two cases at three and a half years; also, in two cases with Bertin at four years; Trojanowsky at five years; Luzinsky and Clemens at six; Hürlin, Trojanowsky, and Höring in two cases at seven; Murchinson at ten; Luvín at eleven; Clemens at fifteen; Heyfelder in his own person at twenty-seven years.
Meigs & Pepper ..	Treatise on diseases of children. 7th Edit. p. 774.	Scarlatina: The authors have seen three cases of recurrence. In one case a child, the interval was two years. In the other two cases, both children, the interval was four and one-half years. Another case is recorded under the observation of a competent practitioner (name not given) in which the interval was nearly four years. It has been asserted that second attacks of scarlatina do not occur once in a thousand cases, the authors, however, takes exception to the statement.
Edward Ellis .....	Manual of diseases of children. 3rd Edit., p. 48.	Scarlatina is usually a non recurring disease; if it recur, is mostly in a mild form—Scarlatina latens.
Thomas .....	Zeimssen Encyclop. Pract. Med., Vol. II, p. 42.	Measles: Van Dieren reports the case of a girl aged three who was attacked by measles in February, 1848, and recovered, but was again attacked on March 4, recovered and was again attacked April 12. Brisbaum relates a case in which measles appeared three times before the thirteenth year.



## CHAPTER VI.

### PREVENTIVE INOCULATION AGAINST CHOLERA.

#### SECTION I.

##### *INTRODUCTORY REMARKS.*

We have already discussed the confirmation of the discovery of Koch and his associates of the German Commission, viz, that the specific microbe, the so-called comma bacillus of Koch, is the invariable accompaniment of Asiatic cholera and furnishes a reliable means of prompt diagnosis. The further opinion expressed by the German Commission, that this microbe is also to be regarded as the real cause of the disease, for various reasons lacks proof of confirmation to some degree. Among the difficulties in the way of the establishment of this proof may be mentioned the following: There are none of the domestic or other animals which are known to be naturally susceptible to Asiatic cholera, and attempts at inoculation of animals have usually failed or furnished more or less unsatisfactory evidence that genuine Asiatic cholera has resulted after the introduction of the comma bacillus of Koch into their organisms, because of the more or less marked variations of the symptoms produced from those commonly observed in Asiatic cholera in man. This latter has also been a difficulty that experimenters have had to deal with in undertaking by experimental researches to prove the etiological relations of germs which were considered to be the cause of disease in man. Even in the case of tuberculosis, because of the dissimilarity more or less wide between the symptoms and the pathological lesions of tuberculosis in cattle and other animals, and in those of man, medical authorities were for a long time divided in opinions as to whether the disease was or was not identical.

It seems reasonably probable, however, that the disease which had been successfully produced in some of the lower animals by experiments with the comma bacillus of Koch, notwithstanding its considerable divergence in symptomology from Asiatic cholera in man, is really of the same essential nature, notwithstanding the fact that experimenters have had to deal with animals which have no natural susceptibility to the disease. One objection against the results of these experiments, urged more or less persistently by opponents of the general germ theory of disease, and also by those who have solely denied the specific infectious nature of Asiatic cholera, is that enormous quantities of the germ have been required to produce effects. But in estimating the weight of these objections it must be remembered that there is a general law concerning infection which shows that the quantity of the specific virus required to produce the disease in a given animal is in inverse proportion to its susceptibility. The application of this law to the matter in discussion would seem to lead one rationally to expect that in the case of an animal known to have no natural susceptibility, a large quantity of germs should be required.

In the chapter on ptomaines, and in that relating to the bacteriological literature of cholera investigations, appear a few scattering observations which indicate that those animals which have survived the experimental introduction, either by feeding or inoculation experiments, of cultures of the comma bacillus of Koch, have acquired a more or less positive immunity from the effects of subsequent attempts to produce the disease in them. The same remark may also

be made concerning the effects of cultures in which the living microbe had been killed, as well as the effects of alkaloids, or ptomaines, which have been separated from such cultures by chemical process. A Spanish physician, Dr. Jaime Ferrán, a native of the city of Tortosa, was the first to undertake to demonstrate the existence of immunity in cholera by experimentation upon animals, and to make a practical test of this belief upon the human subject on a very extensive scale. In view of the great importance of the subject, the writer deemed it his duty while in Spain to make as thorough and searching an investigation of the Ferrán experiments and inoculations as was possible during the time that he was there, although at the commencement of that examination he was imbued with the popular prejudices among scientific physicians throughout the world against the personal character and scientific attainments of that investigator, as well as the quality of the evidence up to that time published concerning the methods and results of the human inoculations; for here was a possible opportunity of obtaining proof concerning the etiological relation indirectly between the comma bacillus of Koch and Asiatic cholera in man through direct experiments upon the human being upon a vast scale. Moreover that examination might furnish again indirectly evidence concerning the existence or not of immunity after an attack of Asiatic cholera. By reference to the following abstracts of official and other reports concerning these Ferrán inoculations, it would appear that there is *prima facie* evidence sufficient to warrant the presumption, first, that the comma bacillus of Koch is the cause of Asiatic cholera in man; second, that there is an immunity following an attack of cholera; third, that an immunity of some duration may be established artificially by inoculations of pure cultures of the comma bacillus of Koch; fourth, that by the practice of these inoculations extensively among the populations suffering greatly from cholera, an epidemic can be rapidly extinguished. The evidence, such as it is, seems to tend almost universally in this direction.

It is true that the first two official reports upon the Ferrán inoculations, presented respectively to the French and Belgian Governments, were decidedly adverse to the claims of Ferrán, but it is to be noted that the circumstances surrounding the visit of these commissions to Spain were such as to place great difficulties in the way of their obtaining precise and unbiased knowledge concerning the matters which they were commissioned to investigate. Among the chief difficulties may be mentioned the fact that at the time of their visit to Spain there were but few if any official statistics concerning the results of inoculations in existence and accessible to them. Furthermore, the intense partizan sentiment concerning the Ferrán inoculations, on the one hand, and the establishment of rigorous sanitary cordons on the other, was of such a character that at that time it was scarcely possible to obtain fair and unbiased information from the officials by whom these commissioners were surrounded in Spain. On the other hand, the personal disputes which at the very beginning arose between Dr. Ferrán and the visiting foreign commissioners made it difficult for them to form other than highly prejudiced impressions concerning Dr. Ferrán himself. The accounts given of these visits and the comments thereon by Dr. Ferrán himself, are abstracted from his book "*La Inoculacion Preventiva Contra el Colera*" are introduced in this report.

Notwithstanding the wide-spread popular and professional prejudice which existed in America and all over Europe against Dr. Ferrán on account of the unfavorable reports and severe criticisms made against his character and scientific qualifications and his inoculation work, both in the laboratory and among the various villages in Spain, where the anti-choleraic inoculations had been practiced, presented to the French Minister of Commerce by M. Brouardel and his associates, as well as those presented respectively to the Belgian and French Governments by Drs. Van Ermengem and Gibier, and which were extensively published and commented upon in the secular and medical press, upon visiting Spain, having been charged by the President with the duty of examining every question relating to the origin, progress, prevention, and cure of cholera, I felt it my duty to investigate as closely and impartially as possible the whole Ferrán question. Before my arrival in Spain all the other foreign commissioners had reached that country, made their



investigations, returned home, and published their reports; and the reports of the numerous Spanish commissions representing both the general and the provincial governments of Spain had also been published. Having already before visiting Spain become *au courant* with the literature of the subject, I had nothing to do with respect to the Ferrán question while in that country further than to personally seek information concerning the character and scientific attainments of Dr. Ferrán and obtain possession as much at first hand as possible of all facts relating to the human inoculations so extensively practiced in several of the provinces which were then obtainable.

Not only had unfavorable impressions of Ferrán been conceived by me through the perusal of what had been published adversely concerning him and his anti-choleraic inoculations in Spain by the medical and secular press throughout the world, but in addition to this I had been strongly advised, before my departure from America and after my arrival in London and Berlin, by numerous physicians and investigators for whose opinions I entertained the highest respect, that a personal investigation of the Ferrán question was now beneath the dignity of serious scientific consideration. I was therefore, upon my arrival in Spain, but little disposed, except by a sense of duty, to give myself any trouble to inquire into the character and accomplishments of Ferrán, or into the nature and value of the so-called anti-choleraic inoculations.

But, besides the impulse of duty to examine all questions which might possibly relate to the prevention of Asiatic cholera, a circumstance occurred on my arrival in the city of Valencia, the main theater of the practical operations of Ferrán, which determined me, as far as within my power lay, to make a close inquiry into this question. The morning after my arrival in that city I was honored with a visit from an English physician resident there, whose *carte de visite* was inscribed with his name and title, and gave the further impressive information that he had formerly acted as body physician to ex-Queen Isabella and to various other princes, potentates, and high dignitaries of Spain. This gentleman was a certain Dr. Jelley, a man apparently of some seventy years of age, who appeared to be strongly convinced of his own consequence. He stated, as the object of his visit, his desire "to set me right on the Ferrán question before I had wasted any time in personal investigations relating thereto." This gentleman had been the principal correspondent of several of the chief British medical journals concerning Ferrán and his operations in Spain. All of these communications I had previously read in the journals to which they were addressed and been impressed by them, and I was glad of the opportunity of forming the acquaintance of their author, and of judging for myself of the importance and reliability which should be attributed to them. In the course of this interview I soon became convinced by the manner and language of this gentleman, not only that he was personally incompetent to form any judicious opinion concerning questions involving an intimate knowledge of modern ideas relating to general pathology or to microscopic investigations, especially to those relating to bacteriology, but also that whatever opinions he might form concerning the question of preventive inoculation against cholera by Ferrán and his assistants were very likely to be influenced and warped by the most bitter partisan prejudices. His parting remark at the end of the visit is a fair sample of many expressions to which he gave vent in the course of our somewhat protracted interview. We had been discussing a certain Dr. Cameron, a member of the British Parliament, who had communicated to one of the prominent British periodicals an article in which he had set forth some statistics relating to the inoculations, which he had been enabled to obtain from various sources, and he concluded his article with a strong indorsement of Ferrán and an urgent recommendation to the British Government that it undertake serious investigations to prove the truth or fallacy of the claims of Ferrán with a view to having the method of anti-choleraic vaccination tested in India, the natural home of cholera. Dr. Jelley informed me that as soon as he had read this article of Dr. Cameron, he had addressed that gentleman a letter begging him to desist from further publications or action upon the subject until he (Dr. Jelley) could have an opportunity to lay the truth of the whole matter before him; and, á propos of this subject, Dr. Jelley made the parting remark, "If Dr. Cameron had persisted in his course, it was my (Dr. Jelley's) intention to go to England and *hound him down*."

This interview with the author of many communications concerning the preventive inoculations in Spain, which had contributed largely to my preconceived adverse prejudices concerning the matter, at once convinced me that, while I had the opportunity, I should personally go to the bottom of the whole Ferrán question, if possible.

From the city of Valencia, which had been the center of the scene of his operations, I made a short visit to Dr. Jaime Ferrán at his home in Tortosa, a small town in the province of Tarragona. I was courteously received by Dr. Ferran, both as a scientific representative of a country for which he expressed great admiration and as a private individual desirous of learning the truth about the matter which had been the subject of so much dispute. I found the home of Dr. Ferrán to be of very modest pretensions, seeing no external evidence whatever of the possession of the wealth which, among other things, he has been charged by his adversaries with having unjustifiably obtained by the exaction of enormous fees for the performance of his inoculations. His laboratory, of which so much has been said, was certainly very unpretentious. It consisted of a small room without windows or door other than that through which it communicated with an adjoining room which served the purpose of a private consulting cabinet. Both these rooms were on the ground floor, the latter overlooking the river Ebro, directly upon the left bank of which the house was located. The floor was covered by a wooden grating. The room was supplied entirely by artificial light, and by means of this light it could be seen that the numerous shelves against the walls of the room were somewhat dusty, as well as the various forms of apparatus which rested upon them, such as instruments, glass flasks, test tubes, etc.; and between the wooden grating covering the floor dust and dirt were quite visible. There was no water-closet in this room that I could see at the time of my visit. At that time the room contained two microscopes—an old one of the ordinary old-style Nachet pattern, furnished with a corresponding system of lenses, and a newer one consisting of a very good and conveniently modeled Hartnack stand, furnished with special substage illuminating apparatus, being a modification of that of Abbé, with several oculars and two or three objectives, among which was an excellent Hartnack high-angle water-emersion No. 12. With this modern microscope it will be readily understood that Dr. Ferrán at that time was furnished with the necessary means of making careful and exact observations, so far as the microscope is concerned, of the morphological characteristics of the comma bacillus of Koch as well as those of other bacteria. Indeed, Dr. Ferrán demonstrated for me very fairly a number of bacterial preparations, including the comma bacillus of Finkler and of Koch, even with his old Nachet instrument and Nachet objectives, which latter were by the way superior lenses of that class.

Notwithstanding the absence of the scrupulous cleanliness which is so desirable in the surroundings of a bacteriological laboratory, I found among the numerous preparations arranged upon the shelves of this laboratory cultures of the comma bacillus of Koch, and of the curved bacillus of Finkler and Prior as pure and perfect in their various characteristics as I have seen such cultures anywhere else in the world, not even excepting the laboratories of Berlin or Paris. During my stay in Tortosa Dr. Ferrán very kindly and apparently with entire willingness showed me everything that I desired to inquire into. He made cultures before my eyes of the comma bacillus, and I afterwards saw them growing, revealing their customary characteristics. He made numerous cover-glass preparations for microscopic examination, also under my personal observation, from the various cultures which he had undertaken to make at my suggestion. I saw him perform every step in the operation, from the abstraction of the small fraction of a drop of the culture from the gelatine tubes by means of a sterilized glass rod drawn out to a capillary extremity to the mounting in balsam for the permanent preservation of the stained film upon the cover-glass.

After having read so much, in the current literature of the day, about the ignorance of Dr. Ferrán of the modern methods of research among bacteria, and of his inability to make decent microscopic preparations, and of his absolute ignorance of the method of staining, I confess that it was with some surprise that I witnessed the facility with which he performed all these operations—a facility which indicated the *habitual* practice of no mean skill in the per-



formance of these somewhat delicate operations; and my astonishment was great when for the first time I examined with his Hartnack microscope one of the cover-glass preparations which I had seen him make. Honesty and regard for fair dealing require me to say that if there are more beautifully stained microscopic preparations of bacteria, especially of the comma bacillus of Koch, and of the Finkler and Prior bacillus, anywhere in Europe, I have never seen them.

What I have to say with regard to the personal bearing, mental capacity, intelligence and demeanor of Dr. Ferrán is also very different from much of what I had already read concerning this gentleman. Prepared to find the characteristics of a charlatan, I met with nothing in the several interviews which I held with Dr. Ferrán which suggested anything of the kind. I found him to be a quiet, reserved, courteous, intelligent, and generally well informed physician. The impressions which I formed of his theoretical knowledge of bacteria and of the modern methods of research in the field of natural history, have compared very favorably with those of most of the leading bacteriologists with whom I have come in contact. I therefore left Tortosa with a very different opinion concerning the character and accomplishments of Dr. Ferrán than I had entertained before making my visit to that city.

#### THE HUMAN ANTI-CHOLERAIC INOCULATIONS IN SPAIN.

And now with respect to the human inoculations: The most of these inoculations were performed in villages in the province of Valencia. The number of persons inoculated considerably exceeds 30,000. Much has been both said and written in Spain, France, and England concerning the results of these inoculations. The results which have been published have appeared to very strongly back up the claim of Dr. Ferrán that choleraic inoculation has the power of protecting the individual against an attack of cholera, and that the extensive practice of this inoculation among villages already invaded by the epidemic is a powerful and at the same time harmless means of bringing the epidemic to an end. This being the case, for those who were unwilling to accept the deductions to be made from the published statistics, the only way of escaping their force seemed by an attack upon their validity.

The statistics of the anti-choleraic inoculations have been widely attacked. The first public onslaught upon these statistics of which the world, outside of Spain, had much knowledge, was made in the report of the French Commission, with Dr. Brouardel at its head, which was presented to the Minister of Commerce after the return of that Commission from Spain in the summer of 1885. It is charged in that report that the results of the statistics therein reproduced are assailable on account of having been collected by physicians who were partisan supporters of Dr. Ferrán, and that they neither possessed any adequate official character, nor did they possess sufficient details. As far as I can learn, the general impression entertained throughout the world of the value of the inoculation statistics is based, in the main, upon this report of the French Commission.

The statement of that Commission that the statistics which they had been able to obtain of the preventive inoculations of Ferrán were to a considerable degree void of any official character may be true, and perhaps it is also true that they emanated from the partisan friends of Ferrán; but it must be distinctly remembered that at that day there were practically no official statistics of this kind in the hands of any one. The official statistics collected under the orders of the Spanish Government were gotten together at a far later date.

Upon the appointment by the Government at Madrid of the second official Spanish Commission to investigate the Ferrán question in the provinces where the inoculations were being practiced, it was ordered that official statistics of the inoculations should be collected in the usual manner; that is to say, by the customary statistical officers of the Government. This second medical Commission was also accompanied by an independent statistical commission who were charged with the duty of forming statistics of those inoculations which were expected to be witnessed by the Medical Commission in their tour of investigation, and the report to the Spanish Government of this statistical commission is based exclusively upon the official statistics which they themselves collected.

In estimating the value of the official character and the authority of the official statistics,

which have since the visit of the French Commission to Spain been collected and published, the following circumstances should be taken into account: The provincial governments of Spain are somewhat peculiar, in that the civil governors change with the changes which take place in the Government at Madrid, so that the political constitution of the provincial governments is always a reflex of that of the central Government at Madrid. Moreover, the political sentiment of the provincial government is also more or less perfectly reflected by the local governments of the towns of the province.

The hostility of the Minister of the Interior at Madrid to Dr. Ferrán and his attempts at the prevention of cholera by inoculation, is a well-known fact now generally admitted; and the hostility which Dr. Ferrán met with from the civil governor of the province of Valencia was even greater than that manifested by the Minister of the Interior himself.

The official statistics of the Ferrán inoculations are in the first place signed by the physicians of the locality; in the next place by the judge of the municipal court, and sometimes also by the president judge of the judicial district, by the parochial priest, and by the mayor of the municipality, whose signatures and seals are attested by an authorized notary public.

It must, therefore, be obvious that the charge made by the French Commission, which has been so constantly reiterated everywhere, that the public statistics of the anti-choleraic inoculations are void of official character and are to be regarded as *ex parte* testimony of the partisans of Ferrán, can not apply to official statistics which were collected under the supervision of the municipal authorities of the villages wherein the inoculations were performed and attested not only by the local judicial officers and the parochial priests, but also by the political officers—that is to say, the secretaries and the mayors of the municipalities; for it must be admitted that neither the political officers of the municipalities nor of the provincial governments, any more than the parochial priests, can reasonably be charged with being the partisans or friends of Ferrán—the Minister of the Interior continuing during the time of collection of these official statistics to be hostile to the claims of Ferrán. It therefore follows that the attack upon the statistics of the inoculations made by the French Commission, and so widely accepted by the medical world as conclusive, does not apply to the official statistics of which we are speaking. And, in view of this fact, the evidence as to the efficiency and harmlessness of the anti-choleraic inoculations should be re-examined. As I have already said, the results of the preventive inoculations of Ferrán, as set forth in the official statistics, appear to very strongly support his claim of the protective value of the inoculations. In view of the great importance of this whole subject I have determined to place these statistics in this report for the benefit of the readers of the English language, in order that they may judge for themselves of the facts as they appear to be recorded.

From the Government statistics of cholera throughout the province of Valencia, it appears that among the villages invaded there were 62 attacks per thousand of the population, and 31 deaths per thousand, which gives a mortality of 50 per cent. of those attacked. It appears from analysis of the published official statistics of cholera in 22 towns where inoculation was performed the inhabitants were divided as follows: 104,561 not inoculated; 30,491 inoculated. Of the latter there were 387 attacks of cholera or 12 per thousand, and 104 deaths, or 3 per thousand; the mortality of those attacked being 25 per cent. Of the former there were 8,406 attacks, or 77 per thousand, and 3,512 deaths, or 33 per thousand; being a mortality of those attacked of 43 per cent. It appears, therefore, that among the population of villages wherein anti-choleraic inoculations had been more or less extensively performed the liability of the inoculated to attacks of cholera was 6.06 times less than that of the non-inoculated; whilst the liability of the inoculated to death by cholera was 9.87 times less than that of the non-inoculated. These figures are based exclusively upon the data furnished by inoculations, the re-inoculations being left out of consideration, because they are much less numerous, although from the records of the inoculations it would seem that the liability of attack, and especially of death by cholera, is many times less among them than among those inoculated a single time.

The charge has also been made with respect to the published records of the inoculations



that the hygienic and physical condition of the subjects of inoculation have not been sufficiently indicated in the records, and that the vast majority of those profiting by the opportunity to receive the anti-choleraic inoculations were of the middle and upper classes, and therefore not of that class of the inhabitants who are notoriously most liable to attack and death from cholera. This criticism may have some justness as respects some, perhaps many, of the villages where inoculations were performed, but there are certainly many of the villages wherein the results of the inoculation seemed to be most positively in favor of the claim of Ferrán where this criticism can not hold. I refer to villages wherein three-fourths or four-fifths of the inhabitants were inoculated, leaving only the fraction of the population non-inoculated. Even in the absence of any special notes indicating the social conditions and hygienic surroundings of the inoculated in these villages, it is ridiculous to assume that the vast majority of these were people of the middle and upper classes, and were therefore but little liable to attack and death by cholera. Any one acquainted with the character of the Spanish population as it exists in the rural villages, will admit at once that the vast majority of this population consists of the wretched and the poor who live under the most unhygienic and unsalubrious conditions, and therefore are of that class most liable to suffer from cholera.

There is still another result of the preventive inoculations of Ferrán apparently shown by these statistics. I refer to the apparent marked shortening of the course of the epidemic after a large percentage of the inhabitants have become inoculated. It would seem, therefore, from analysis of the official statistics that the practice of the anti-choleraic inoculation after the method of Ferrán, besides giving the subject inoculated a considerable immunity from attack and death by cholera, furnishes a means of bringing an epidemic rapidly to an end.

In view of the great extent of the anti-Ferrán literature, I deem it just to introduce in this report also some of the literature in defense of Ferrán, so that the people of this country may know both phases of the question in order to rationally judge between them. At the same time I deem it advisable also to incorporate the reports of some investigations which appear to throw a strong light upon the general question of immunity.

#### *FERRÁN'S METHOD OF PERFORMING (ANTI-CHOLERAIC) INOCULATIONS.\**

The majority of the precautions which should be taken in vaccinating a greater or lesser number of individuals is condensed in the following instructions addressed to the physicians who had to perform the inoculation, and which in a separate sheet were handed last spring to our colleagues. We insert them here in full for the purpose of showing the care which we took in all of the details relating to the operation :

#### “INSTRUCTIONS FOR THE PRACTICE OF THE PREVENTIVE INOCULATION AGAINST ASIATIC CHOLERA ACCORDING TO THE METHOD OF FERRAN.

“(1) The cholera vaccine is nothing more than a pure culture, in bouillon, of the comma bacillus. Its easy and long preservation (four to five days) allows of its transportability to great distances, taking care always to keep the flask which contains the material upright.

“(2) Heat and cold do not interfere with its preservation if the vaccine is to be used in a short time. It should not, however, be kept out of doors during the warm season.

“(3) The vaccine should be kept in flasks of the model of Ferrán, with a flat bottom and a short neck. The stopper, which is of rubber, fits perfectly, and is penetrated by two glass tubes, one straight and short, which does not extend below the inferior surface of the stopper, and which does not project above more than some two centimeters, is plugged with a small quantity of sterilized cotton and a superficial covering of wax. The other glass tube is longer, and extends on the lower side as far as the bottom of the flask, while its superior end is curved, and terminates in a capillary extremity, the tip of which is closed with wax.

“(4) When the vaccine is to be used it is necessary to make two principal preparations for

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\*From Capitulo XXI. La inoculación preventiva contra el cólera. Por J. Ferrán. Valencia, 1886.

the operation. A small syringe for the hypodermic injection and a small vessel into which it is necessary to empty the fluid from the flask are required. The syringe should have metallic pistons and mountings without mastic of any kind and without rubber. Its capacity should be one cubic centimeter, its needle thicker and shorter than that of ordinary use. Before beginning the vaccination the syringe must be filled two or three times with boiling water, which is aspirated and expelled through the needle. This is called sterilizing the instrument, and by this means the extraneous germs are destroyed which might be contained in it, in order to avoid the production of plegmons and abscesses. The trouble in taking this precaution will be little. Acting thus, one may perform thousands of injections without fear of any accident. It is suggested that it is a bad custom to pass the needle through a flame in order to sterilize it, because this mode of procedure draws the temper. Another precaution that must be taken relates to the examination of the syringe before using it in order to be well assured that the piston acts perfectly and that not a single drop of the liquid escapes by a leak in the canula. This latter defect is sufficient to reject the instrument. If the syringe aspires air because of the leather washer which is placed at the end of the glass tube in order to facilitate its adaptation is dry, or the piston is in the same condition, it is necessary to delay a little while in order to take the syringe apart and soak it in warm water. It is convenient to keep several syringes for use, with a sufficient number of needles, when many inoculations are to be performed.

“(5) The small receptacle into which the vaccine is poured in order that the syringe may be filled readily is a capsule, a cup, or some similar vessel. Before use, it should be washed and dried with extreme care, and immediately before using, passed through an alcohol or Bunsen flame, in order to sterilize it.

“(6) All these preparations having been made, the drop of wax which closes the capillary extremity of the long tube of the flask is removed, and at the same time also the wax covering of the cotton stopper of the short tube, but by no means must this cotton stopper be removed; a rubber tube or the extremity of a small Richardson spray apparatus is adjusted to the short tube. The capillary extremity of the long tube is now slightly warmed in order to soften somewhat the wax which may have been drawn into its lumen by capilarity, and air is forced into the flask, either by blowing into the rubber tube or by working the Richardson atomizer; the air injected by pressure upon the vaccine fluid forces the latter out through the long tube with the capillary extremity, and it is collected in the cup or small sterilized vessel. This latter is then covered with white paper, which has been scorched in the flame, or with a sterilized glass plate; as often as the syringe is filled, this cover will be removed and again immediately afterwards replaced.

“(7) Never should the rubber stopper which closes the flask or the cotton which plugs the short straight tube be removed, because otherwise the germs of the external air might enter and contaminate the culture, and in this way give place to local and general accidents among the inoculated. Whenever, through the movements of transportation, the cotton plug in the short glass tube has become so wet as to impede the passage of the air which is to be forced into the flask in the act of expelling the vaccine from it, it may be removed with the point of a needle and rapidly substituted by another plug of surgical cotton which has been carbonized or salicylized. If this proceeds with cleanness and promptness, there is no danger in doing it. When the cotton, although wet, does not impede the injection of the air, it is better not to change it.

“(8) After terminating the vaccination, again the capillary extremity of the curved tube is passed through the flame until the small quantity of liquid remaining in it is evaporated; it is then stopped a second time with a small drop of wax; and from the other glass tube the rubber tube which has been employed for forcing in the air is removed and another thin layer of wax is placed over the cotton plug.

“(9) If in the smaller vessel or cup any of the vaccine fluid remains after the vaccination of all persons present, it is boiled, and in this manner the culture is killed, for it should not be used in another operation, because atmospheric germs might become mixed with it.



"(10) The technique for the practice of the inoculation is the same as for all hypodermic injections. The most convenient region is that of the brachial triceps.

"(11) The dose is one cubic centimeter—or the contents of a syringe—into each arm, for individuals of all ages and conditions.

"(12) Five days having elapsed, revaccination may be performed by following the same instructions."

#### THE OPINION OF M. CHAUVEAU CONCERNING CHOLERAIC INOCULATIONS.\*

At the meeting of Grenoble, 1884, of the Association for the Advancement of Science, M. Chauveau presented a communication upon choleraic vaccination the spirit of which is indicated by the conclusions which we publish below. By them it is seen that the notion of M. Chauveau concerning choleraic inoculation is very close to our own as respects its efficacy and its harmlessness, although we are not entirely in accord as to the manner of valuing the details of the method.

We pardon the illustrious director of the Veterinary School of Lyons the personal reflections which he makes concerning the scientific foundation of our labors; in spite of his immense superiority over M. Brouardel, M. Chauveau could not entirely resist the influence of the report of the French Commission sent to Spain for the purpose of studying the vaccination against cholera:

#### CONCLUSIONS OF THE INVESTIGATION BY M. CHAUVEAU OF ANTI-CHOLERAIC VACCINATION.

"(1) The subcutaneous connective tissue constitutes for the cholera virus a medium but little favorable for the proliferation of the pathogenic agent and for the development of a malignant affection; this tissue is consequently very fit to serve as a door of entrance for the virus in order to produce an attenuated infection, capable of playing the rôle of a preventive.

"(2) The small similarity which exists between the characters of this rudimentary infection and those of genuine cholera can not be invoked to deny *à priori* the choleraic nature of the slight symptoms produced by the inoculation or to reject them as a basis for the pretension of their conferring immunity against the natural disease.

The efficacy of the preventive inoculation is made probable by the example of analogous facts, as numerous as they are well established, which are well recognized in veterinary medicine.

"(3) In the well-known cases to which allusion has just been made, especially in peripneumonia and emphysematous carbuncle, the virulent infection by the pathogenic agents, properly so called, is undeniable and it is that only which acts in the production of the immunity. The soluble substances contained in the minimum quantity of the liquid inoculated have no direct influence upon the results of the inoculation. There is no reason to suppose that the ptomaines of the bouillon cholera cultures play a more active rôle, notwithstanding the relatively large quantity of the bouillon injected in the inoculations of Dr. Ferrán.

"(4) The greater immunity which, according to the statistics of M. Ferrán, a second and especially a third large inoculation confers, proves nothing in favor of this agency of a soluble poison. It is established in science that *the same attenuated culture* inoculated repeatedly *in very minute quantities* augments each time the immunity against the strong virus, thanks to the multiple action of the slight infection resulting from the inoculation.

"(5) The tolerance of the human organism for large quantities of the infectious bouillon should probably be explained not only by the unfavorable conditions of the surroundings of the bouillon at the locality of the puncture, but also by its weak virulent activity. In effect it is possible that the cultures of the comma bacilli in sterilized bouillon made under the ordinary conditions are naturally attenuated. Nothing would be more easy, if it were necessary, than to attenuate them further by heat. The comma bacillus belongs to the class of pathogenic microbes whose activity is very easily modified by heat.

\* Loc. cit.

“(6) The quantity of the virulent material which must be inoculated ought to be regulated according to the activity of said material. It is, then, possible that the liquid of M. Ferrán may be so little active that it may be necessary to inject it in the dose of a cubic centimeter. But everything prompts the belief that the inoculation would have the same efficacy if they were practiced with two or three drops of the liquid well prepared.

“(7) There is little probability of creating foci of infection by the practice of the anti-choleraic inoculations, because the subjects inoculated are not under conditions favorable for the production and dissemination of the malignant germs.

“(8) The demonstrated facts authorize, therefore, in principle, the attempts at preventive inoculation of cholera by the injection of fluid cultures of the comma bacillus into the subcutaneous tissue. These facts explain the harmlessness of these inoculations, but *à priori* do not warrant the affirmation of their efficacy; the proof of the latter is a matter of experimentation concerning which only comparative and rigorous statistics will furnish conclusive evidence.

“(9) From this research it results that there is reason to follow with interest the inoculations of M. Ferrán, notwithstanding the slight scientific character of his prior investigations and of his active practice, as there is also for testing the results which he has published. I am ready to lend my aid to those who may desire to devote themselves to such a test.”

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FERRAN'S COMMENTS ON CHAUVEAU.\*

We are entirely in accord with some of the propositions formulated by M. Chauveau. On the other hand, we hold a contrary opinion against the third and fourth, founded as it is upon the results of our experiments related in the notes directed to the Academy of Sciences of Paris, and repeated in this book.\* A small quantity of the culture of the comma bacillus, however rich it may be in germs, does not confer, as M. Chauveau thinks, the same degree of immunity as the injection of a greater dose (see Laws of Habit in the same work). The same peculiarity is observed with respect to other virus. Assuredly by often repeating injections of small doses a sufficient immunity would be obtained; but in an epidemic of cholera it is important to gain time and obtain the greatest degree of immunity possible with one, two, or three vaccinations.

With respect to the sixth conclusion we must affirm that our cultures are very rich in comma bacilli and possessed of the activity which this micro-organism commonly enjoys. Their attenuated effects are due to the little receptivity at the site of inoculation, to the greater or lesser richness of the culture in the commas, and to the quality of the latter. The site of puncture and the abundance of commas course, we can vary at will; with respect to the last we know nothing, but it is indubitable that there are cultures more virulent than others, although having, apparently, the same quantity of germs. These differences in the virulence can be avoided in practice by giving the virus the greatest uniformity possible: besides, they do not constitute the least difficulty for the practice of inoculation. Respecting the affirmation in conclusion 9, we have only to regret that M. Chauveau should have passed judgment upon our investigations without being acquainted with them, except through the unbiassed relations of his compatriots. We are sure, from the admitted severity and uprightness of the chief of the School of Lyons, that he will be somewhat more just in his later writings, rectifying all that may appear to him injurious to us.

We feel confident that the opinions of M. Chauveau will be accepted by some, and that the preventive inoculation against cholera, such as we practice it, and without fundamental modification, will be vindicated before the gross attacks with which some have sought in vain to annihilate it.

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\* Loc. cit.



*THE MODE OF INTRODUCTION OF THE VIRUS IS CAPABLE OF EXERCISING A CONSIDERABLE INFLUENCE UPON ITS EFFECTS.\**

Let us elaborate this proposition:

Such a virus as that of glanders, anthrax, etc., manifests its effects upon animals enjoying the greatest susceptibility always with the same activity, whatever the mode of entrance into the animal economy.

Whether it is introduced into the digestive tract, the blood stream, the deep layers of the epidermis, or the subcutaneous connective tissue, it always produces glanders or malignant anthrax, usually of a fatal type.

But this indifference of the virus, as respects its mode of entrance into the animal economy, is not a general law. With the vaccine virus, for example, the studies of Chauveau have proven that the state of affairs is quite otherwise.

Upon bovine animals the superficial cutaneous inoculation occasions characteristic pustules. Subcutaneous injection never produces them, but develops only a more or less voluminous swelling of the connective tissue. In both cases the animals are beautifully and well vaccinated, for subsequent cutaneous inoculations entirely abort. Finally, if you inject the virus into the blood stream, you will produce no effect; its action on the animal will be *nil*—so completely *nil* that if you re-inoculate by superficial punctures of the skin the latter will become the seat of magnificent vaccine pustules.

In equine animals the vaccine virus comports itself in the same manner, but with a variation, the existence of which has proved of great value for theories concerning immunity. Intravascular injections of the vaccine are no longer inactive in this species, as in cattle. In very rare cases the activity of the virus betrays itself by the development of a vaccinal exanthema more or less like that of the natural disease. Most frequently however, no local or general sign of the disease is manifested, save a very slight and passing elevation of temperature; but the injection creates in every case, without exception, immunity to the vaccinal disease to such a degree that it is no longer possible to produce the vaccine vesicle by subepidermic punctures.

Chauveau calls especial attention to this last point. When it is desired to create an artificial immunity against a disease, *it is not necessary to produce the disease or a group of symptoms more or less faintly resembling it.*

The attenuation of the effects may be carried to the point of rendering the disease absolutely unrecognizable, to the point where it might be said even that there is no disease at all, and yet the immunity produced by this semblance of artificial disease will not be less sure.†

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*REPORT ON THE STUDY OF CERTAIN OF THE CONDITIONS OF INFECTION.*

By W. WATSON CHEYNE, of London.‡

Mr. Cheyne, after a careful series of exhaustive experiments, arrives at the following conclusions:

*Conclusions.*—I do not propose in this preliminary report to enter at length into all the conclusions which might be drawn from these experiments, because the research is not yet concluded; but I may refer to one or two of the results from the experiments on guinea-pigs with the bacillus anthracis, on mice with the bacillus of mouse septicæmia, and on rabbits with the bacilli of chicken cholera and rabbit septicæmia. We see that in the case of animals highly susceptible to a disease the minutest possible dose of the virus (one bacillus) is capable of producing it. On the other hand, from the experiments on rabbits with proteus vulgaris, with staphylococcus pyogenes aureus and albus, and with the tetanus bacillus, on

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\* L'immunité par les leucomaines, par E. G. B., 1886.

† Congrès de Grenoble, Le Temps, 16 aout 1885.

‡ Brit. Med. Jour., 1887.

cattle with charbon symptomatique, and on dogs with rabies, we see that when the animals are not so susceptible to the disease in question a certain, and often a considerable, dose of the virus is necessary to produce a fatal result. And, further, we see from the experiments on Algerian sheep with anthrax, and on guinea-pigs with rabbit septicæmia and chicken cholera, that even with these highly pathogenic organisms a certain dose is necessary in the case of animals less susceptible to the disease; and in the case of mouse septicæmia on rabbits a very large dose failed to cause a fatal result. In these cases it seems that the resisting power of an animal to a disease may often be overcome by the introduction of a large dose of the virus. I think we may venture to express the facts in the form of a law as follows:

*The pathogenic dose of a virus varies inversely with the predisposition of the animal to the disease in question; the greater the predisposition to the disease, the less is the quantity required, and conversely, the less the predisposition, the larger is the dose required, until ultimately the point is reached when no amount of virus will produce an effect.*

Another point which will be observed, and which is noticeable especially in the case of proteus vulgaris, is that the severity of the local affection often stands in direct relation to the amount of virus introduced; and we may, I think, safely accept it as a second law regulating infection.

*In animals not very susceptible to a disease the severity of the disease varies directly within certain limits with the amount of the virus introduced.* This follows from the results of the experiments with proteus on rabbits, with chicken cholera and rabbit septicæmia on guinea-pigs, with anthrax on Algerian sheep, with charbon symptomatique on rabbits. In all those which I have investigated I found three stages, according to the dose injected: A stage where with a small dose no apparent effect was produced; an intermediate stage where a local affection resulted, the extent of the local affection depending much on the dose of the virus; and a stage where with a large dose death followed. Of course this law does not apply to cases where the animals are very susceptible to a disease, as, for example, to those instances where one bacillus can produce a fatal result. It is only where a certain number is required to produce any effect that the severity of the disease may depend on the quantity introduced. Nor does it necessarily follow that the same dose will produce the same effect in all individuals of the same species. Hence the question of predisposition, and accordingly the first law comes into play—with like predisposition, and the other conditions equal, the same effect would be produced by the same doses. But where the predisposition and other conditions vary, the effects of the same dose will also vary. In the same individual, however, the severity of the affection will within certain limits vary directly with the initial dose.

Again, from a study of the length of time before symptoms or fatal results followed the injection, we may formulate a third law, namely, that *up to a certain point the length of the incubation period varies inversely with the amount of virus introduced.* The limit of invariability in the length of the incubation period is, however, not very great. It is only when very small doses are employed that any relation to the dose can be observed.

Then, again, we find that in several instances a small dose protects the animal from the fatal effect of a larger dose; but this is evidently not a universal law.

A fifth point of importance which these investigations have brought prominently into notice is the site of infection, the effect of the virus depending in some cases on the point where it enters the body.

The bearing of these facts on the spread of epidemic diseases and on the course and the severity of infection in man will be evident to all; but the precise state of matters in regard to man can only be ascertained after further investigation based on the facts made out with regard to the lower animals.

I may refer to one or two instances on which the foregoing facts may throw light. As I said at the commencement of this paper, Ogston some time ago asserted that the difference between simple acute inflammation and pyæmia and septicæmia was in the main a question of dose, a supposition which at the time I was not at all inclined to accept; for, in the first place, Ogston's researches by no means proved that it was the same organisms which were present in



simple abscess as in pyæmia; and, in the second place, I knew no facts to favor the idea that different effects followed different doses of a virus.

Rosenbach's researches, however, have shown that the organisms found in pyæmia are the same as those often present in acute suppuration, and the results of this research, establishing a difference in the effect according to the dose of the virus, strengthens Ogston's views very much.

Take again the example of anthrax in man. In some cases it is a purely local affection, and the patient recovers; in others it is a fatal blood disease, as in many cases of wool sorters' disease. These different effects may depend on differences in virulence of the bacilli; but they may also depend on the dose introduced and the predisposition of the patient to the disease. We do not know the average susceptibility of man to the bacillus anthracis. It may be that in all cases a certain dose is required to produce the disease. If that is the case, then the law comes into play that the severity of the affection varies directly with the amount of the virus introduced, and the question whether a general or a local effect would follow the introduction of the anthrax poison would depend on the amount of the virus introduced. On the other hand, it may be that human beings vary immensely in their susceptibility to this disease, when of course the dose might be the same in the two instances and the effect depend on the predisposition of the patient to the disease, in accordance with the first law.

In the same way in epidemics the occurrence of severe cases among mild ones may depend on differences in predisposition to the disease, but may also with a similar predisposition depend on differences in dose. Nor must we forget the possible effect of a small dose in lessening the predisposition of a patient to the disease, or, indeed, in abolishing the predisposition altogether.

The action of these laws in the spread and virulence of epidemics will also be evident. I may illustrate their action in the case of cholera, although I have not investigated the cholera bacillus from this point of view, and therefore these speculations may be erroneous. Nevertheless they will serve to illustrate the point. I will start by assuming that in the case of cholera a certain dose is necessary to produce the typical disease; that one cholera bacillus, even if it gained entrance to the intestine, would be insufficient. Nor is this assumption at all improbable when one takes into consideration the mode of outbreak and spread of this disease. Now, let us suppose a quantity of cholera virus to be introduced into a particular locality. What happens? It is deposited on the soil, in the water, etc., and, according to the conditions in which the bacillus finds itself, it grows or it does not grow. If it is deposited in a place where the sanitary conditions are good (in other words, where the conditions are adverse to its growth), it either dies out or it grows slowly, with difficulty. If it grows at all it may be that small numbers or small doses find their way into the intestines of some of the inhabitants through the food, drink, etc. But these quantities being small would be insufficient to cause the virulent disease and would either produce no effect at all or only a mild diarrhœa. Hence we find that in places where the sanitary conditions are good, cholera does not spread at all; or, on the other hand, along with attacks of virulent cholera in the neighborhood there may be in these places only an extra number of cases of mild diarrhœa, and for aught we know this mild attack may be sufficient to protect the patient, for a time, at least, against a stronger dose. On the other hand, take the case where cholera is introduced into a locality where the conditions are favorable to the growth of the bacillus outside of the body. The bacilli increase rapidly under the favorable conditions, and hence large doses may be taken in, and very soon an outbreak of the virulent disease results. Again it is often observed that after the introduction of cholera into a certain locality an interval elapses before the general outbreak of the disease in which, besides isolated cases of the virulent affection, there are a number of cases of mild or severe diarrhœa. May not this in some instances depend on the comparatively slow growth and diffusion of the bacilli, so that, in the beginning of the epidemic, only small doses are as a rule taken, these doses being insufficient to cause a virulent affection, but sufficient to cause a slight illness, which may protect the individual, at least temporarily, from the fatal effects of large doses. After a time the bacilli will have spread to such an extent that large

numbers are swallowed and produce the typical affection in predisposed individuals. May not such a view help to reconcile the observations on the relation of cholera to particular soils and regions with the fact that the virus must be introduced from without, and what can hardly now be regarded as other than the fact that there is a causal relation between Koch's cholera bacillus and Asiatic cholera?

There is one other point to which I may refer, namely, to protective inoculation, more especially with reference to Pasteur's inoculation of animals for anthrax. Whatever be the explanation of the mode of action of protective inoculation, the fact may be expressed by saying that it lessens or abolishes the predisposition of the animal to the disease in question. There can be no doubt from the experimental work which has been done on this subject that according to the strength of the vaccinating material and the mode of vaccination there are all degrees between complete protection and no protection at all. And, as we have seen, when the predisposition of the animals is lessened the pathogenic dose may be increased. Now, an important question, and one which has been much debated, is this: Are Pasteur's inoculations of sheep for anthrax of any practical value? This is a question which has been answered in the negative by several eminent observers, and yet the statistics of Pasteur's inoculations are so striking that I think one must admit that they do good. There can be no doubt from Koch's researches that in the process of protecting sheep *absolutely* from anthrax a large number must die; and as after Pasteur's method very few die, the protection of his animals can not be absolute. Pasteur, admitting that, asserted that the natural process of infection was not so virulent as the artificial inoculation. Koch showed, however, that while animals protected by Pasteur's method did not succumb after artificial inoculation, a certain proportion of them died, if fed with anthrax spores. And yet, in anthracic districts, of the flocks inoculated by Pasteur's method fewer individuals died of anthrax than before protection. Now, is there no way out of this dilemma? I think the preceding experiments show us a way. There can be no doubt that Pasteur's inoculations, while not protecting the animals absolutely, greatly lessen the predisposition of the animals to the disease; and hence, according to our first law, a very much larger dose is necessary to kill than before. The whole question is, then, whether they get this large dose while feeding on infected pasture. I believe that the explanation of the facts is that they do not usually do so; that they are sufficiently protected to resist the small dose which, without this protection, would prove fatal. Hence the inoculations are really of value. Koch's experiments, from which he concluded that the natural way of infection was more virulent than the artificial, do not now seem to me to bear that interpretation. He experimented on sheep already partially protected, and administered enormous numbers of spores by the mouth; and there seems little doubt that a much larger dose was given by the mouth than subcutaneously. I would, therefore, suggest that the intestinal dose was sufficient to overcome the resisting power of the animal, while the other was not. This is a point which could be easily determined experimentally by any one who has had the opportunity of doing so. I have taken this instance as illustrating the light thrown by the foregoing experiments on the subject of protective inoculation, and I must leave the reader to apply them to protection in the case of man.

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#### THE LAWS OF INFECTION.\*

Among the more positive results relating to the study of pathogenic micro-organisms achieved during the past few years have been those of Watson Cheyne and of Wyssokowitsch. They bear upon the laws regulating infection, and demonstrate almost absolutely the fact that there is really in some diseases a battle between the tissue cells and the bacteria. Mr. Cheyne, in a research intended to discover the dosage and virulence of infective germs, found that the initial dose of virus was of great importance, and in several instances exercised a marked influence on the course and virulence of the disease. In a summary in the

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\* Medical Record, 2119, 1887.



British Medical Journal, it is stated that various laws are made out; for example, the pathogenic dose of a virus varies inversely with the predisposition of the animal to the disease in question; in animals not very susceptible to a disease, the severity of the affection varies directly within certain limits with the amount of the virus introduced, etc. It was found that in some cases a small dose of a virus produced only a local effect, while a larger dose killed the animal, and the small dose might protect the animal from the fatal effect of a subsequent large dose. Although it is as yet impossible to measure predisposition, and thus to decide the dose for any individual, nevertheless the knowledge of the relation between these two factors is of the utmost importance as throwing light on the mode of spread of epidemics; while the fact that a considerable quantity of the virus is in many cases necessary for the production of a disease explains many anomalies, and affords indications for preventive measures.

The results of the more recent work in injecting micro-organisms into the blood are given in the British Medical Journal. In 1874, Traube and Gescheidlen found that, if a quantity of putrid fluid were injected into the blood of rabbits and dogs, and the blood taken twenty-four hours later, with aseptic precautions, no organisms developed in it, showing that the bacteria introduced had disappeared from the blood or had been destroyed in it in that short time. Some years later Watson Cheyne found also that saphrophitic bacteria, when injected into the blood-stream of rabbits, disappeared from the blood in twenty-four or forty-eight hours, and he concluded that they had been destroyed in it. Pursuing the subject further, he found that if larger quantities were introduced along with the fluid in which they grew, they were able to survive for a longer time, and that the same was the case with smaller quantities, if the animals experimented on had been previously weakened in health by the administration of repeated doses of phosphorus or other poisons. He explained this fact on the supposition that the products introduced with the larger quantities of putrefying fluid, or the poisons previously administered, had so weakened the vitality of the blood and tissues that they were no longer able to destroy the bacteria. Wyssokowitsch has repeated the experiments and has come in the main to the same conclusions as Watson Cheyne, but he has added several interesting observations. In the previous researches, mixtures of bacteria, probably not containing spores, were employed; but Wyssokowitsch used pure cultivations of known organisms and found that, while sporeless bacteria were rapidly destroyed, the spores could retain their vitality in the body for a long time, and remain in the tissues in a dormant state. (See Report of Wyssokowitsch's experiments in the British Medical Journal.)

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#### *IMMUNITY FROM ANTHRAX BY INJECTION OF CHEMICAL BODIES.*

By Dr. L. C. WOODBRIDGE.\*

Dr. L. C. Woodbridge recently communicated to the Royal Society a method by which he had been able to protect rabbits from anthrax, which is of considerable interest in connection with the general question of the nature of protection in this and other diseases depending on micro-organisms. The method consists in cultivating the anthrax bacillus in an alkaline solution of a peculiar proteid body which can be obtained from the testis and thymus gland. The growth of the microbes is not abundant, and after two days at 37° C. they are removed from the culture fluid by filtration. A small quantity of filtered liquid is injected into the circulation of a rabbit and the animal can then withstand the inoculation of extremely virulent anthrax blood. The bacillus, itself, grown in this culture fluid, has no protective influence. It either kills or it has no effect. The result is extremely curious, for hitherto protection against zymotic diseases has been effected by the communication to the animal of a modified form of the disease against which protection is sought. In Dr. Woodbridge's experiments the protection must be produced by some chemical body—the product of the activity of the bacillus. This observation belongs to the new order of facts and appears to fall in with Pasteur's theory as to the method in which

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\*Brit. Med. Jour. 5, 11, 1887.

immunity to hydrophobia is produced by inoculation of the spinal cord of rabbits. Both find some support in Professor Cash's experiments with perchloride of mercury, in which it was shown that after animals had taken a sufficient quantity direct, they were no longer liable to anthrax.

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*IMMUNITY PRODUCED BY AN ALBUMOSE ISOLATED FROM ANTHRAX CULTURES.*

By E. H. HANKIN, of Cambridge.\*

The following is a brief preliminary account of an investigation which I have recently been engaged upon under the guidance of Professor Koch, at the Hygienic Institute of Berlin. The results appear to have an important bearing on the theory and practice of preventive inoculation.

It is now generally admitted that acquired immunity against a disease is in reality an acquired immunity against a poison. The phenomena of acquired tolerance of the effects of ordinary albumoses, and of snake poison which contains a poisonous albumose, show a closer resemblance to acquired immunity against a disease than is the case with any other poison. These and other facts led me to expect that if it were possible to isolate an albumose from anthrax cultures such anthrax albumose would probably be capable of conferring immunity against the disease. Such an albumose I have now isolated from my culture fluids by ordinary chemical methods, and find that it gives the ordinary reactions for albumoses, and that it is capable of conferring immunity.

In the course of my process of preparation it is precipitated from its solution by addition of a large bulk of absolute alcohol, and well washed in this liquid to free it from ptomaines, since it is known that all such substances are soluble in alcohol. After the addition of alcohol it is filtered off and dried, then it is redissolved and filtered through a Chamberland's filter. A rough estimate of the percentage of albumose present in the clear solution thus obtained is made colorimetrically, by means of the biuret reaction and a peptone solution of known strength.

In one experiment four rabbits (Nos. 23 and 26) were inoculated subcutaneously with virulent anthrax spores. No. 26 served as "control," and died in about 40 hours. The other three rabbits had the albumose solution injected into the ear vein at the same time. Nos. 24 and 25 each had about the five-millionth of their body weight, while No. 23 had only the ten-millionth of its body weight of albumose. No. 25 died in less than 48 hours, but Nos. 23 and 24 survived. Ten days later Professor Koch kindly re-inoculated these two rabbits for me with very virulent anthrax from an agar-agar culture. Their temperature has remained normal since then, and they are now alive and well a fortnight after this operation.

I have also succeeded in producing immunity in mice against attenuated anthrax. Dr. Fraenkel kindly gave me an agar-agar culture of the second vaccine. From this I made bouillon cultures, and whenever I inoculated a rabbit from these it always died, unless it had at the same time been protected by a dose of the anthrax albumose. Unfortunately, when a few days later I was inoculating mice with these cultures, after a dose of anthrax albumose, I omitted to inoculate a control rabbit, so that although the culture showed itself virulent for my control mice, I have no certainty that it was still virulent for rabbits. The following experiment shows its effect on mice after treatment with anthrax albumose:

Seven mice had each the millionth part of its body weight of anthrax albumose injected hypodermically. Two others had each the five hundred thousandth of its body weight. A week later they were all inoculated with the second vaccine. Two control mice were also inoculated, and of these one died in about 36 hours; the other was exceptional, inasmuch as it died only after 108 hours. Only one of the three mice which had the five hundred thousandth of its body weight of albumoses survived. Of the 7 mice which had been protected by the millionth of their body weight of albumose 4 died. So that in this experiment, out of 10 mice inoculated, only 4 showed immunity against anthrax.

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\* Brit. Med. Jour., 1889.



In another experiment 10 mice were each inoculated with the millionth part of their body weight of anthrax albumose and with the second vaccine at the same time. Of these, 3 died after 108 to 116 hours; the others survived. Three others had only the two millionth of their body weight of anthrax albumose and second virus. Two of them are now living. Four control mice were inoculated, and all died.

In my earlier experiments I gave larger doses of anthrax albumose, and on inoculation with anthrax the animals died, often before the control animals. For instance, I have had several cases of mice dying 12 to 16 hours after the inoculation with virulent anthrax. In the spleen pulp of rabbits and guinea-pigs, however, I almost always found, under these conditions, numerous phagocytes. In these the bacilli showed sometimes signs of degeneration, but more often appeared to be alive and growing. Sometimes the long chains of bacilli, so characteristic of the growth of attenuated anthrax, appeared to be growing out the cells. In one case (a rabbit which died only 150 hours after inoculation) the only bacilli that I could find in the spleen were contained in phagocytes. I have found these phagocytes in rabbits not only after inoculation with the second vaccine, but also after virulent anthrax. In mice I have never found phagocytes, but often after a large dose of albumose and attenuated anthrax the bacilli in the spleen appeared to be in longer chains than in the control mouse. The appearance of these phagocytes and chains of bacilli led me to try the effect of very minute doses of anthrax albumose with the favorable results described above, for the possibility suggested itself that these phenomena were indications of a commencing immunity. In several experiments the animals received the anthrax only after several days of a large dose of albumose; but in these cases also death ensued in a longer or shorter time than usual, according to the quantity of anthrax albumose injected, while numbers of phagocytes were usually to be seen. Apparently the albumose had remained in the system, or at any rate only a small part of it had been excreted. Beyond this power of conferring immunity with a small dose or of hastening the course of the disease with a slightly larger dose, this albumose does not show clearly any physiological action in the quantities employed. I often noticed, however, that for a couple of days after larger doses the mice appeared to be sleepier than the controlled mouse living in the same cage.

Although the following inferences seem capable of explaining the above results more simply than any other theory, I do not pretend that they are as yet satisfactorily proved. I only wish to assert that my results make it probable that—

First, the anthrax bacillus owes its power of living in the animal body to its power of producing a poisonous albumose.

Second, that this poisonous albumose is capable of suppressing the "germicidal power" of the living animal.

Third, that this albumose seems to be very slowly excreted.

Fourth, that if a large dose of this albumose is injected into an animal the entry of anthrax bacilli into the system is aided.

Fifth, that if a very small dose of this substance is administered tolerance is acquired against its poisonous properties. Consequently, when after a few hours or days the anthrax virus attempts to suppress the germicidal power of the animal by means of its albumose it is unable to do so, because the animal has already acquired tolerance of its poisonous quality.

Sixth, with a dose of anthrax albumose intermediate between that employed in the above two cases death ensues in the usual time or (in other cases) life is generally prolonged. Apparently in this case complete tolerance of this comparatively large dose of albumose is unattained. Consequently the anthrax bacilli are able to live and produce more of their albumose and at length by this means overcome the resisting power of the animal.

My observations have been made on over a hundred mice and about fifty rabbits. My best thanks are due to Professor Koch and Drs. Fraenkel and Weyl for their very kind advice and assistance.

## INVESTIGATIONS CONCERNING POISONOUS SUBSTANCES PRODUCED BY BACTERIA.

By L. Brieger and Carl Fränkel, of Berlin. \*

These authors relate the details of a very thorough research upon the chemical products to be found in cultures of the Loeffler bacillus of diphtheria, of the typhoid bacillus, of the anthrax bacillus, of the tetanus bacillus, of the cholera bacillus, and of the staphylococcus aureus. For a full account of these researches the reader must consult the original paper.

In bouillon cultures of the Loeffler bacillus of diphtheria they have found a substance which, by its chemical constitution and behavior, should be classed with the albuminoids, and which possesses marked poisonous properties. According to the results which they have obtained, they think that they are not unwarranted in expressing the opinion that *this albuminous substance plays a very important rôle* through the characteristic action upon the organism of the bacillus diphtheritica of Loeffler. They hold also that they have found other bacterial products, of a similar constitution and behavior, to which they—in contradistinction to *toxin*—give the name of *toxalbumin*, are elaborated, and that these latter substances appear to be even more important than the former.

Within the living body this *toxalbumin* is doubtless built up out of the albumen of the tissues and decomposed again, by which the latter, through a transposition and alteration of its atomic groups, acquires poisonous properties. For the demonstration of this, however, further experiments must be undertaken.

In their artificial cultures the toxalbumin certainly originates from the blood serum which is added. These authors, it need not be said, tested the nutrient fluid for a poisonous substance which might have been formed by the numerous processes through which it had gone before inoculating it with the bacteria, but with negative result. In those cultures which contained no serum, but in which, nevertheless, a poisonous substance was elaborated, this could only have been produced from the peptone *which had been undoubtedly converted back again into albumen*.

All of these discoveries, the authors say, may at first glance seem strange; but they refer in this connection to the fact that poisonous albuminous substances had already been discovered before their investigation.

The toxalbumin of the bacillus of diphtheria has, for example, a certain similarity to ichthyotoxicum, which A. and U. Mosso obtained from the serum of murenids by precipitation with ammonium sulphate. One of these authors has been for some time engaged with U. Mosso in the more exact determination of the remaining properties of this substance.

Robert and Stillmark have recently found poisonous albuminous substances in the vegetable kingdom, which, according to the observations of Sidney Martin, appear to be phytalbuminous, especially so in the case of vicinus from the castor-oil seeds. Introduced into the blood current, the vicinus kills even in the dose of 0.03 of a milligramme per kilogramme of body weight after having caused a hemorrhagic inflammation of the intestinal canal, rapid loss of strength, and finally cramps, collapse, etc. By boiling the vicinus solution completely lose their power.

After obtaining a toxalbumin from cultures of the bacillus of diphtheria, the authors undertook the search for a similar poisonous substance elaborated in cultures of other micro-organisms. They thus subjected bouillon or bouillon-blood-serum cultures, respectively, of the typhoid, tetanus, and cholera bacillus, and of the staphylococcus aureus, as well as watery extracts of the internal organs of animals killed by anthrax, to the same methods of investigation which they had employed in the bacillus of diphtheria; that is to say, they passed the fluid through the Chamberland filter, evaporated it in vacuo at 30°C. down to the third part of the original volume, poured this into ten times the quantity of absolute alcohol, added a few drops of acetic acid, filtered off the precipitate, endeavored to dissolve the same in water, etc., or they decomposed the filtrate with ammonium sulphate, dialyzed it, and so on.

Respecting the details of the results obtained in this series of experiments it is sufficient

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\* Berliner klin. Wochenschr., Nos. 11 and 12, 1890.



to say that the authors found in the cultures of each of the above-named micro-organisms substances which, by their chemical constitution, are characterized as albuminous, possess poisonous properties for animals, and may, therefore, according to these authors, be designated as toxalbumins.

This fact for one of the above-named bacteria was already investigated from one standpoint, and probably ascertained before we examined the question. As a result of a large series of investigations which have been conducted in the Hygienic Institute of Berlin, Hanbury Hankin announces that he has obtained from cultures of the anthrax bacillus by means of precipitation with alcohol, drying, solution in water, and, finally, filtration through a Chamberland filter, an albuminous substance, by the use of a very small quantity of which he confers an immunity upon animals which are highly susceptible, such as mice and guinea-pigs, against a subsequent injection of the living anthrax bacilli.

Furthermore, Christmas has likewise, by treating cultures of staphylococcus aureus with alcohol, obtained an albuminous substance which, introduced into the anterior chamber and into the subcutaneous tissue of rabbits, excites suppuration, which that author regards as the characteristic action of this peculiar albuminous substance elaborated by the above-named micro-organisms.

Brieger and Fraenkel state that the substances found by them should be divided into two groups, which are distinguished from each other by very remarkable properties.

In contradistinction to the toxalbumin of the diphtheria bacillus, the substances isolated from cultures of the typhoid bacillus, of the cholera bacilli, and of the staphylococcus aureus are insoluble, or with great difficulty soluble in water. They are, therefore, not to be ranged, like the former, with serum-albumin, but are to be classed nearer to the globulins, although they are separated from them also, since they only slowly and with difficulty dissolve in dilute solutions of sodium chloride. The substances give the usual albumin reaction, but are precipitated by neutral salt, when heated to 30° C. ; they present still other differences which the authors leave to be described in a later communication.

A solution of the purest possible toxalbumin of cholera bacteria injected into the subcutaneous tissue of guinea-pigs killed these animals in two to three days. At the autopsy only a marked swelling and reddening of the subcutaneous tissue as well as of the abdominal muscles in the neighborhood of the point of injection were found, whilst there was not a trace of necrosis, etc. The intestine was unchanged, no effusion in the pleural cavity, in the liver sometimes, the indication of fatty degeneration, the kidneys presented nothing noteworthy.

For rabbits the toxalbumin of the cholera bacteria was remarkably inactive, even in large quantity. The albuminous substance, soluble in water, obtained from cholera cultures possessed no poisonous properties either for guinea-pigs or for rabbits.

As to the toxalbumin of the typhoid bacillus, a substance soluble with peculiar difficulty, rabbits showed themselves more susceptible than guinea-pigs. They died in eight to ten days after the introduction into the subcutaneous cellular tissue, without there having been noted at the autopsy any visible alterations. In this case also was the substance soluble in water entirely inactive.

The toxalbumin of the staphylococcus aureus killed rabbits and guinea-pigs in a few days, sometimes even after twenty-four hours. The anatomical appearances, besides evidences of intense inflammation, were a marked swelling and reddening of the entire neighborhood of the injection, at the point of injection an extensive necrosis or, speaking more correctly, a purulent solution of the tissue, which under certain circumstances had penetrated through the muscular wall into the peritoneal cavity and excited a peritonitis. The pus in its appearance could not be distinguished from the common pus of wounds, however, proved to be entirely free of bacteria. The substance soluble in water was quite inactive.

The toxalbumin of these three species of bacteria is different therefore different from that of the diphtheria bacilli, whilst that of the anthrax bacilli approaches again the toxalbumin of diphtheria since it is very readily dissolved in water. On account of the difficulty of cultivating a large quantity of anthrax bacilli within a short time in fluid nutrient media, these

authors have up to the present sought to obtain the anthrax albumin only from the organs of animals which have died of anthrax. The liver, spleen, lungs, kidneys, etc., of rabbits were chopped into fine pieces and rubbed up with water; the fluid after standing 12 hours in an ice chest was passed through a Chamberland filter, and subsequently treated in the manner already so frequently above described. The substance obtained had when dry a grayish white color, the albumin reactions, and was, as stated, soluble in water.

The toxalbumin of the tetanus bacillus, isolated from grape sugar bouillon cultures of this organism, is soluble in water. A guinea-pig which received a subcutaneous injection of this substance became sick in four days with cramps, difficulty in walking, and a short time thereafter died.

Finally, it may be here remarked, in the form of an appendix, that we (these authors) have examined also an animal poison, namely, that of the cobra, as to similarity of behavior to that of our toxalbumin. Through the kindness of Professor Koch, they received a small quantity of snake poison in the form of a dry, yellowish white, irregular granules. This material, whose extraordinary activity, demonstrated upon mice and guinea-pigs, was dissolved in water, and then treated with alcohol rendered acid by acetic acid, and so forth. The poisonous substance was precipitated by this treatment, whilst the alcoholic extract thus obtained was quite harmless. Since the precipitated substance responded to the reaction for albumen, for the present we may class it with the above named substances. It may be remarked here, say these authors, that S. Weir Mitchell and Edward T. Reichert have separated from the cobra poison two poisonous albuminous bodies; the one, *globulin*, precipitable by water; the other, a peptone, which is not separable by means of alcohol. Mitchell and Reichert stand in a certain contradiction with these authors. Brieger and Fraenkel would explain this by the assumption that it is possible that even with careful treatment, such as solution in water or drying, treatment with alcohol, etc., the constitution of these substances may become changed, without indeed losing their poisonous qualities, and that differences such as the above are to be explained in that way.

#### SUMMARY.

These authors have, to use their own language, thus found that an entire series of different micro-organisms, among them the most infectious, which, in their artificial cultures and in the body of the animals killed by them (experiments with anthrax bacilli), elaborate substances that, according to their chemical qualities, are to be regarded as direct derivatives of albumen, and that possess such a decided poisonous character that we have given to them the name of toxalbumin. These authors believe that these substances, through the noxious action of the pathogenic bacteria, play a very important rôle and occasion the ordinary symptoms and, under some circumstances, also the death of the animal attacked. Since the toxalbumin is elaborated in the body of the animal, doubtless from the albumen of the tissues, and does not fundamentally differ from it, so the latter acquires an enhanced interest in pathology. The distance from the normal constitution of the body to substances of the most dangerous kind appears shorter than we formerly imagined, and our bodies themselves seem to be the immediate cause of the morbid conditions which are brought about through the vital processes of the bacteria.

In truth, a great mass of the weightiest questions the authors admit have been scarcely touched or have been quite passed by. Why do the easily soluble toxalbumins act with such extraordinary slowness? In what way does the noxious influence of the poisonous albumose become at first effective? What is the essential basis of their toxic qualities, etc.?

Willingly had these authors borne in mind at least some of these points and endeavored to contribute to their demonstration, and they mistake not that the results which they here communicate are scarcely more than preliminary and bare the stamp of lack of preparation and imperfection.

Concerning two of the above propounded questions, namely, the relations of the toxalbumins to the rise of the body heat to fever, as well as their relations to the establishment of immunity artificially, the authors hope in a later publication to give some account.



## ON THE POISONOUS PRODUCTS OF SAPROGENOUS BACTERIA.

By Dr. ADOLF BAGINSKY and Dr. MAX STADTHAGEN, Berlin.\*

In a communication upon the pathology of cholera infantum (in No. 46, 1889, *Klin. Woch.*) the proof has been given by us that some of the bacteria cultivated from the fæces of children affected with cholera infantum elaborate very poisonous substances, which we have shown to be in most part ammonia. The suggestion has already been expressed that it may be possible "that besides the ammonia still other products of decomposition in the intestinal canal may come into play, which, up to the present, have escaped chemical investigation." It has since then been demonstrated that the diarrhetic fæces besides ammonia indol contain phenol, whilst we can not find in it sulphuretted hydrogen. Since then we have further prosecuted investigations concerning the elaborated products of saprogenous bacteria of the intestines. To this end has been used a bacterium in pure culture which presents a whitish fluidifying coloring upon whose resemblance, if not identical with Finkler-Prior's, was remarkable. This bacterium pretty rapidly rendered 10 per cent. gelatine fluid in the form of a pouch and grew in the hanging-drop bouillon cultures into long threads. The bacterium, placed in association with bacterium aceticum (bacterium lactis of escherich) in flesh-peptone-gelatine containing sugar of milk, often lost the possibility of further growth so that the gelatine may become fluid. This peculiarity would seem to indicate that the acid re-action of the culture medium brought about by the breaking up of the sugar of milk hindered its growth, which, however, did not proceed so far, as further study proved that the bacterium introduced into milk produced such a quantity of acid as to cause coagulation. The development of the bacterium is not so closely related to the alkalining of the culture medium as at first appeared to be indicated; furthermore, it can still be made to grow when inoculated upon gelatine plates even from sour milk in which coagulation has taken place, which rendered possible the proof of the possession of pure cultures.

This bacterium was inoculated upon slices of horseflesh which had been sterilized in cotton-closed flasks by four times heating for five hours in live steam. Already within the first twenty-four hours a visible cloudiness of the bouillon standing above the pieces of flesh was observed, if the flasks were kept in the culture oven at a temperature of 35° C. After proof of purity of the contained culture was established by plate culture, the flesh was subjected to chemical investigation after ten days of fermentation. It was shown by examination that through this fermentation neither sulphuretted hydrogen nor phenol and indol were present; on the contrary, considerable quantities of ammonia were found. By investigation of the bulk of material for poisonous bodies, after Brieger's method, a substance in the form of a double-gold salt was obtained, which, as well on account of its form of crystallization as also on account of its other properties, is probably identical with the substance having the formula  $C_7N_{17}NO_2$ , obtained by Brieger from decomposing horse-flesh. It differs from the latter substance only by a somewhat higher melting point of the double-gold salt. We will recur more particularly to this substance in another place. We have therefore found a substance of exceedingly poisonous qualities in the pure cultures of a certain bacterium obtained from the intestinal canal of children affected with cholera infantum, which Brieger had discovered in horse-flesh after four months of decomposition (not controlled by bacterial cultures).

Interesting as this discovery was, it appears, however, to be insufficient to explain those foudroyante symptoms which are met with in the course of attacks of cholera in children, and which we were inclined to connect not so much the specific action of one species of bacteria, as with the decomposing action of a group of bacteria, as one of us (Baginsky) has already advanced in the above-cited work. We were obliged, therefore, to make responsible as cause of the poisonous action substances which might belong to an entirely different group. The observations which we had already made, that the alcoholic residue of many decomposed masses possesses marked toxicity, as well as that a large portion of their poisonous action is lost

\* Berliner *Klin. Wochenschr.* No. 13, March 31, 1890.

by prolonged heating, are intimately related to the idea that the individual bearer of this poisonous principle is to be sought for among the albuminous substances.

In this direction one of us (Stadthagen) has already announced investigations in a previous work, "On the Urine Poison." (Zeitschi, f. Klin. Med. Bd. xv., Heft. 5, 6.); and Virchow and Panum in the case of putrid infection and ichorhæmic intoxication had been led to think of poisonous substances which stand closer to the albuminous than to the discovered basic bodies; finally, we were in a situation where, in considering noxious substances which originate in the intestinal tract, we were very near the opinion that these substances might belong to the peptines or to their immediate derivatives. Imbued with these ideas we subjected to a new investigation horse-flesh, which was inoculated with our bacterium after previous sterilization, and then kept ten days in the incubator at 35° C. The injurious boiling of the horse-flesh by Brieger's method was avoided, and the fluid obtained through pressure of the solid material was thrown upon the filter and washed through with at least ten times its volume of absolute alcohol. A grayish-white, viscid sediment formed, from which the alcohol could be easily decanted, whilst the rest of the fluid was separated by filtration. The substance thrown down by alcohol contained sulphur, was not at once and completely dissolved in water, and was with great difficulty afterwards dried over sulphuric acid. The watery solution gave with ammonium sulphate a further precipitate. Furthermore, the watery solution presented all the properties of peptone solutions. On the contrary, neither globulin nor other albuminous substances, nor propeptone could be demonstrated in the fluid or in the watery extracts of the residue of the fleshy mass; the latter also no longer contained myosin, as can be shown by treatment with solution of sal ammoniac and filtration. The peptone mass obtained from the fluid, after drying over sulphuric acid, was dissolved in water and after filtration used for subcutaneous-injection experiments upon mice. After two hours the animals were still apparently well; after five hours they suffered slight dispnoea and the hair was erect; the animals sat still, with lowered head, could be made to move only with difficulty, but showed no decided lameness. Further on, sticking together of the eyelids, very great apathy while sitting still, with much sunken head. In this condition the animals died after two to three days. The autopsy showed a local infiltration at the point of injection, large hyperæmic spleen, liver engorged with blood, both of which latter organs were friable and flabby; there was injection of the peritoneum, hyperæmia of the whole intestinal canal, a collection of a large quantity of a red-brown fluid in the small intestine and a few solid masses of fæces in the colon.

The action of the poison proved to be more intense the richer the injection fluid was in peptones, as shown by the chemical reactions. The non-filtered injection material only suspended in water acted with special force. A short heating of the injection fluid up to the boiling point decidedly weakened its action, without entirely destroying it. It was, *à priori*, scarcely to be believed that the mass obtained from absolute alcohol contained still viable bacteria, and inoculation directly into flesh-peptone-gelatine showed that the material used for injection was sterile. The death of the animal was, therefore, not brought about by the action of bacteria, but induced directly by the visibly powerful noxious substance.

*Thus was it demonstrated, that a bacterium, belonging to the saprogenous and cultivated from diarrhæic fæces, had elaborated out of flesh a poisonous substance belonging to the peptones besides a very poisonous base and besides ammonium.*

With the same bacterium, experiments with sterilized milk were undertaken. We did not succeed in finding in this milk the above described ptomaine which had been extracted from the horse-flesh, although we obtained from the milk substances which gave precipitates with the different alkaloid reagents, including the gold and platinum chlorides. These were always amorphous (albumenoid), non-crystalline compounds. The unfiltered milk had become decidedly poisonous, even after three days action of our bacterium at 35° C., so that mice and rats died after injection, under the above described appearances. It seems as if the toxicity at first increased and then entirely disappeared, if the bacterium has been active in the milk long enough to completely coagulate it. The coagulation takes place with abundant formation of acid, and even an addition of a decided quantity of carbonate of lime scarcely retards it in spite of vigorous agitation. The peptone-like substance obtained from the milk by dropping into



absolute alcohol and filtration appears in many respects to behave somewhat different from that obtained from flesh. The exact description we postpone; it may be mentioned, however, that this substance gives only a very weak biuret reaction, is not very easily soluble in water, and is not precipitable out of slightly acid solutions by means of alkalies.

We surrender, as we frankly acknowledge, the foregoing investigations only unwillingly to the public, because we are still in the midst of our work, perhaps only at its very commencement. We have been led to publish through the interesting and important communication of Brieger and C. Fraenkel in the last number of this journal. We are glad that we have obtained results analogous to those of the above named authors, and by similar methods, concerning the proof of an albuminoid poison elaborated by bacteria, and we shall further labor to establish the chemical properties of the discovered substances.

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#### THE TOXIC PRODUCTS OF THE BACILLUS OF HOG CHOLERA.

By FREDERICK G. NOVY, of Ann Arbor.\*

This author has succeeded in isolating two chemical bodies from the cultures of the hog cholera microbe—the one a toxine, the other a toxalbumine. With the latter, by successive inoculations in gradually increasing doses, he has succeeded in rendering the rat immune against inoculations of cultures of the living microbe of hog cholera. The author concludes a lengthy report of his researches upon the subject with the following language:

To summarize the results which have been obtained from the study of the chemical products of the bacillus of hog cholera, we may say that when grown in proper nutritive material it forms:

First. A basic toxic substance, or ptomaine, *susotoxine*.

Second. A toxic proteid substance, or *toxalbumin*.

Third. That this toxalbumin is capable of producing immunity in rats against the action of virulent bacillus (of hog cholera).

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#### A PRELIMINARY STUDY OF THE PTOMAINES FROM THE CULTURE-LIQUIDS OF THE HOG-CHOLERA GERM.

By E. A. VON SCHWEINITZ, of Washington.\*

This author makes a preliminary report of chemical researches aimed at the discovery of special chemical substances produced in cultures of the hog cholera germ, not feeling that his investigations are sufficiently far advanced to warrant a detailed report, which latter, by the way, is promised in the near future.

His short communication is prefaced with an acknowledgement of the work in this direction done as early as 1887 by Dr. Theobald Smith, of the Bureau of Animal Industry at Washington. According to him, Dr. Smith was the first to demonstrate that the substances produced by bacteria in their growth in culture media could be used for purposes of preventive inoculation. Dr. Smith succeeded in producing immunity from hog cholera by inoculating pigeons with sterilized culture liquids of the hog-cholera germ.

Dr. Von Schweinitz isolated two substances from his cultures, an alkaloid or ptomaine, and an albumose. He does not seem, however, to have found either of these substances very toxic for the guinea-pig (the animal used for this test).

The author says that the detailed results of the experiments in preventive inoculation which have been conducted, are not quite ready for publication.

“The statement may be made in advance, however, that by inoculating guinea-pigs with certain chemical compounds which I have prepared, the animals have been rendered immune from hog cholera.”

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\* Med. News, Sept. 6, 1890.

*THE HISTORY OF MICROBIAN PRODUCTS WHICH FAVOR INFECTION.\**

BY PROF. CHARLES BOUCHARD, OF PARIS, FRANCE.

(1) It is not uncommon to see two different species of microbe invade at the same time an animal organism ; the result of this mixed infection may be widely dissimilar. Sometimes the two pathogenic agents develop side by side, without any reciprocal influence upon each other ; sometimes the animal will find in one of them an unexpected ally against the other, when it would have succumbed to the one affection, it survives the combined attack of the two ; finally the two microbes acting together sometimes overcome an organism which would have resisted successfully either one of the invaders, if attacking alone. It is this last group which is reviewed by the Gazette. The writer remarks that it is the result most frequently seen ; almost always infection intensifies infection.

It is not necessary that the two microbes both be pathogenic in order that their results become virulent ; one of them may be a simple saprophyte. It sometimes happens in fact that two forms neither of which are pathogenic to the animal produce, when associated, death. This has been demonstrated by experiments upon what has been called symptomatic anthrax. The product of this microbe, so virulent for the bovine species, is without action upon the rabbit ; inoculation of this animal, either under the skin or into the muscles, produces with this bacillus no result.

Let us now take another microbe, inoffensive of itself, the bacillus prodigiosus, and mingling it with the microbe of charbon symptomatique, inject it into the tissue or under the skin ; the animal dies and we find at the point of injection a tumor with all the characteristics of anthrax. We here find two microbes, neither of which are pathogenic for the rabbit when injected alone, but which taken together give to one of them a quality which, in relation to this animal, it had not before. The action of the auxiliary microbe, in this case the bacillus prodigiosus, depends upon the matters secreted. The result is the same whether we employ the living cultures, the sterilized cultures, or simply the glycerole of the cultures, that is what has been called the extract.

This power of one microbe to modify the qualities of another does not belong especially to the bacillus prodigiosus ; other forms possess analogous properties. This fact has been established by experiment, by injecting the soluble matters of the staphylococcus aureus, of the proteus vulgaris or of sterilized extracts of putrefying flesh. The facts which have just been stated seem to have a general application, as may be demonstrated by experiments with a large number of different forms. For instance, Flügge and Vissokovitch have shown that certain soluble products render possible the development in the organism of non-pathogenic microbes. Grawitz and Bary have found that the inoculation of the staphylococcus aureus with the secretions of bacillus prodigiosus intensifies the pus-producing power of the former. Recently Monti has rendered virulent the attenuated cultures of the pneumococcus and streptococcus by injecting at the same time the secretions of other microbial forms, and especially of the proteus vulgaris.

These soluble matters which favor infection do not act by altering locally the tissues into which they are introduced ; their action is general upon the whole organism. In fact, the better method where we wish to diminish or abolish the resistance of an animal to invasion, is to inject the soluble products directly into the blood. In this way we obtain the effect with doses twenty or thirty times less, and much more rapidly than when the injection is made at the point of inoculation.

The experimental facts here noted agree perfectly with the results furnished by clinical study. Soluble substances similar to those secreted by the microbes under cultivation are constantly produced in the alimentary canal. M. Bouchard, who has studied with so much care the auto-intoxications dependent upon gastro-intestinal putrefactions, has demonstrated that the putrid poisons absorbed by the portal vein favor a great number of infectious inflammations and render these diseases more likely to terminate in suppuration. They, the soluble

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\* Gazette Hebdomadaire, July, 1890. Jour. Am. Med. Assn., Aug. 30, 1890.



matters, as distinguished from the forms, when taken into the system produce a culture-medium, so to speak, favorable for the development of pyogenic bacteria, and especially of the staphylococcus aureus.

It would seem, therefore, that the most efficient method of combating the infections from this microbe, consists in diminishing the intestinal putrefactions. This scientific deduction is in harmony with the well-known clinical fact that one of the best known forms of treatment for this class of troubles, is by the use of insoluble antiseptics. By this means M. Bouchard has succeeded in arresting promptly the most intense and the most obstinate forms of furuncular disease.

(2) If an animal be inoculated with the secretions of certain microbes, as for instance the bacillus pyocyaneus or of symptomatic anthrax, and if several days afterwards the same animal be inoculated with the living microbe, the previous inoculation having been sterilized, there will be no infection, the animal survives, it has acquired an immunity, in other words it has been vaccinated.

If instead of allowing several days to elapse between the time of the introduction of the secretions of the microbe and the living bacterium, the two are introduced at the same time, the animal succumbs, in fact death is produced more surely and more rapidly than if the inoculation is made with the living microbe alone. It thus appears that bacterian products have two diametrically opposite effects depending upon the time of their introduction as related to the inoculation of the pathogenic form.

This conclusion clearly follows from the experiments conducted by Bouchard with the bacillus pyocyaneus. He says, "I had thought that immunity would be obtained more quickly by injecting *en bloc* the vaccinating matters at the beginning of the malady, than by waiting for this immunity to result from the gradual development of the pathogenic agent. I had imagined that in this manner one would be able to diminish the duration of the disease, and possibly find in these products of bacteria a remedy for the infection itself. Experience has not justified this conjecture. The chemical matters produced by the bacillus pyocyaneus, which cut short, or prevent the disease when injected a few days or a few weeks before the inoculation of the bacillus itself, if injected at the same time as the living form, that is along with it or nearly at the same time; instead of diminishing the intensity of the infection increases it and hastens the death of the animal."

The result is similar with symptomatic anthrax. The matters secreted by the microbe of this disease confer immunity against inoculation practiced several days afterwards. If introduced into the system at the same time as the microbe, they favor the infection, and even render this bacterium pathogenic to animals ordinarily refractory, as for instance, the rabbit. Considerable quantities of the soluble matter secreted by this microbe injected into the veins of the rabbit produced no harm; inoculation of the animal with the living microbe is followed by no morbid symptoms. If the injection of the secretions into the veins and of the living microbe into the muscles be practiced at the same time, the animal dies in from twenty-four to forty-eight hours with an enormous tumor, in fact of anthrax.

This fact enables us to understand how it happens that the inoculation of symptomatic anthrax, in the case of the rabbit into the anterior chamber of the eye, and at the same time into the leg results in the formation of a gangrenous tumor in the leg. Even in this animal the anterior chamber furnishes a culture medium for this bacillus; the development of the microbe in the anterior chamber results in the formation of the soluble products which, absorbed into the blood, renders the inoculation into the muscles virulent. In other words the resistance is abolished.

In relation to the facts just stated it is interesting to compare the results obtained by M. Courmont. In carrying out his experiments upon tuberculosis in the cow, he found that the injection of the secretions of the microbe into the tissues in advance of an inoculation with the living bacilli, instead of producing immunity, increased the susceptibility of the animal to the disease. The absorption of these matters or their introduction produced a permanent predisposition.

These facts relating to tuberculosis are almost exactly the opposite of those reported by M. Bouchard concerning the maladies above named. In the case of the bacillus pyocyaneus and of symptomatic charbon the introduction of the soluble matters secreted by these microbes produce immunity; in the case of the tubercular bacillus on the other hand, the introduction of the products of the microbe produces a permanently increased liability to tuberculosis.

(3) If it is true experimentally that microbial products favor infection by modifying the general condition of the animal, we ought to be able to find out the nature of this modification. The experiments looking toward the solution of this problem constitute the most curious and interesting portions of the memoir of M. Bouchard. He commences by demonstrating, first, that the soluble products do not favor infection by so changing the quality of the tissues or fluids as to present to the attenuated microbe a culture medium in which it regains its virulence.

Attenuated pneumococcus or streptococcus introduced into sterilized broth of putrefying flesh readily develop, but do not regain their pathogenic qualities. A second hypothesis is suggested, namely, that the soluble matters, that is the secretions, are poisonous to the animal, and therefore diminish its resistance to the infection. "In order that this toxic effect may be produced, notable quantities of the bacterian poison must be introduced," says the author. He continues:

"In a majority of my experiments the quantity introduced was too small to produce any appreciable effect upon the general condition of the animal. In the experiments of Roger there was no intoxication from the injection of the products of the bacillus prodigious, though it intensified the effects of the bacillus of symptomatic anthrax; in the rabbit there is in fact no infection, the animal possessing a natural immunity. Poisoning by bacterial products then does not complicate infection, but infection is rendered possible or intensified by the presence of these substances in consequence of some influence which they exert over the processes by which the organism defends itself ordinarily from microbic invasion.

As has been noted in a former number of the Gazette, it is probable that immunity is the result of multiple conditions; we know, however, with any degree of precision of only two modes of resistance to infection, namely, phagocytosis and a chemical alteration of the secretions, so that they resist the action of the microbes or destroy them. Experience seems to show that the presence of these products of bacteria does not modify the quality of the blood by which it destroys microbes, at least in animals vaccinated. There remains only the other hypothesis, that is that these products which favor infection do so by arresting the diapedesis, or migration of white corpuscles, and consequently preventing phagocytosis or the envelopment and digestion of the invading agent. Experiments bearing upon this last proposition were conducted as follows: He introduced under the skin of an animal the microbe to be studied inclosed in a small cell between two plates of glass. Of two animals operated upon, one is reserved for comparison; the other is now subjected to the inoculation of the secretions of bacteria under the skin or into the veins. In the course of three or four hours the glass preparations are withdrawn and examined with the microscope, the number of migratory cells, the number of the microbes inclosed in them, and the number of free microbes in the two cells are compared. The results of these experiments have been extremely definite. The soluble products have arrested diapedesis, and their action has been especially marked when injected into the veins. It will be remembered that this mode of introducing the secretions of microbes had already been found to have the most prompt and certain effect in intensifying infection. If for instance we place under the skin of a rabbit a few drops of a culture of the bacillus pyocyaneus contained in a cellule, such as above indicated, we shall find in the course of three or four hours that there has taken place a very active migration of the leucocytes, and that the destruction of the bacilli is rapidly progressing. But if, repeating the same experiment, we inject simultaneously into the vein 10 cubic centimeters of the soluble products of the same microbe the diapedesis is not produced; there will be found here and there only a few leucocytes. The results are similar with the bacillus of anthrax and with the staphylococcus aureus; the sortie of the leucocytes which these microbes normally stimulates is prevented by the introduction of the microbial secretions effected in artificial cultures. We have here the results reached when an animal is



inoculated with the living form, and at the same time receives into the veins the formless product, in other words the secretion of the same bacterium. We have also seen that the soluble matters of one microbe introduced into the system favors infection by another form. M. Bouchard has demonstrated that the secretions of one species are capable of arresting or preventing the diapedesis which another species tends to excite. The soluble products of the bacillus pyocyaneus, for instance, prevents the leucocytes from attacking the bacillus subtilis, the attenuated bacillus of anthrax in the rabbit, the virulent anthrax in the dog, etc. In all these procedures there had been previous experiments with water, and with simple bouillon, and it becomes therefore certain that the results were dependent upon the relation of the living forms and the non-living product. In pursuing still further these experimental researches we are able to gain some information as to the mechanism by which the unformed products of microbes prevent the migration of leucocytes.

Diapedesis is in relation to the state of the blood-vessels; it is very active when the arteries are dilated; it is diminished or arrested when the arteries are contracted. It has been demonstrated during studies upon the streptococcus of erysipelas that section of portions of the sympathetic which are distributed to the point of inoculation notably increases the migration of leucocytes at the seat of the operation. Small glass cells, such as described above, were placed under the skin of each ear; on one side the superior cervical ganglion was destroyed. At the end of four hours it was found that the leucocytes upon the side from which the nerve had been removed were very much more numerous, in fact thirty to forty times more numerous, than upon the side having the nerve intact. Vascular constriction has an effect exactly the reverse, diminishing diapedesis, and it is by producing this vascular constriction that the soluble products of microbes prevent the migration of the round cells and consequently diminish the resistance of the animal to infection. The invaders are allowed to develop, while the besieged are prevented from making a sortie for the purpose of the destruction of the enemy.

MM. Charrin and Gamaleïa have made some curious experiments bearing upon this problem. By rubbing the ear of two rabbits with croton oil and then injecting into one of them the soluble products of the bacillus pyocyaneus a marked difference was observed in the two animals; in the one not treated with the microbial product there were the usual results of the agent—vascular dilatation and dermatitis with swelling; the other, treated with the bacterian secretion, maintained its normal appearance and condition.

This action of microbial products is transient; at the end of a few hours elimination has been accomplished and the vessels again readily dilate. In this case the morbid predisposition is of short duration; if a certain time elapses between the introduction of the solution and the inoculation with the living microbe, twenty-four hours for instance, it will be found that the resistance of the animal has been restored to its normal condition. In view of these facts it is pertinent to ask, how does the injection of the solution favor the infection? If the elimination is accomplished in so short a time, diapedesis ought to take place and the bacteria should be destroyed. It may be said in answer, that while the soluble matters hold in check the migration of the leucocytes the microbe has had time to develop and to produce its own secretions, so that when the elimination of the introduced product has been accomplished the contraction of the vessels is maintained by the new secretions formed in the tissues or fluids, while the living form continues the work of invasion and destruction.

It is easy to understand how complex fluids, such as those used in these experiments, may produce quite different effects. Matters which favor infection act promptly, but are only transient, elimination rapidly taking place; substances which give immunity require a considerable time to produce their effects, but accomplish a permanent modification of the fluids or tissues. These new facts, established by the experiments of M. Bouchard, serve to explain many obscure points in the history of infectious diseases.

The soluble matters of which the effects have been so thoroughly studied by the experimenter commence to be formed as soon as the microbe begins to develop; they are necessarily related to its normal vegetation. If these matters do not possess the property of contracting the vessels, diapedesis will take place, the leucocytes will come to devour the invading agent,

and in this manner prevent general infection. If the substances secreted, on the other hand, do produce contraction of the walls of the vessels, the escape of leucocytes is prevented, the microbes develop, multiply, and are disseminated; they are pathogenic precisely because they produce a secretion which has this action upon the blood-vessels, in other words a poison to vascular walls.

It would appear that natural immunity must result, in part at least, from the fact that the blood-vessels of the refractory animal are not responsive to the microbial products; that in the presence of these substances the vessels retain their normal properties and diapedesis in the presence of living bacteria takes place, and consequently the destruction of the invader is accomplished. Is the process the same in the case of acquired immunity, that is to say, the resistance conferred by vaccination?

In endeavoring to answer this question we find a new element. Introduced into an organism modified by vaccination, the bacterium does not develop well; the blood and tissues do not furnish a good culture medium, or perhaps we should say the blood and tissues of a vaccinated subject are themselves destructive to bacteria. As a result there is produced by the invading microbe only a minimum quantity of soluble products and it is unable to protect itself from the army of migratory cells. These come to attack a form already enfeebled by a bad soil and unhealthy surroundings, and as a result the foreign agent is easily overcome and destroyed. The animal resists infection, not because the bacterian products have not the power to act upon the vessels, but because the infecting form is not able to produce its normal quantity of these products.

We have here briefly analyzed the experiments of M. Bouchard, which furnish, in part at least, an explanation of the phenomena of susceptibility—of natural immunity—and of acquired immunity, that is by vaccination. Without doubt there is much yet to be done before these complicated and difficult problems shall be entirely solved; problems which up to the time of these studies seemed to defy all explanation. Is it not very much to have revealed to us in part the mechanism of these processes, and by positive and well established facts to have established a general law which accords so well with clinical observations and the results of experiments?

## SECTION 2.

### REPORTS OF OFFICIAL COMMISSIONS CONCERNING THE FERRAN INOCULATIONS.

#### *REPORT OF THE ROYAL ACADEMY OF BARCELONA.\**

We shall occupy ourselves in this part of the work (Loc. cit.) in making known, with some criticisms when they deserve them, the opinions which scientific bodies, national and foreign commissions, and numerous scientific men have enunciated concerning our labors—labors which have been reported in monographs and brochures, or in various publications and in official bulletins. This part will be a necessary complement of our book, and in it will be comprised the judgment of our critics who, on account of their position or the importance of their name, have thought it to be their duty to assist in the solution of the questions involved.

The Royal Academy of Medicine of Barcelona is the first which deserves our attention. Before it our labors were presented by the municipality of the same city which had commissioned us a few months before to study the cholera in Marseilles.

The academy appointed a commission composed of Doctors Bertrán, Soler, Carreras, Giné, Rodríguez, Méndez, and Roig y Soler at its head. These gentlemen dedicated themselves to the laborious task of testing the results of our investigations for two months.

The bacteriological laboratory of the sons of Dr. Carreras, furnished with all the modern

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\*From *Inoculación preventiva contra el cólera morbo asiatico*, por J. Ferrán, Valencia, 1886.  
S. Mis. 92—47



apparatus for investigations of this kind, was constantly at the disposition of the commission, and these gentlemen, besides, gave their intelligent assistance.

The report of the commission, after extended discussion and approval by the Academy, was published in all the medical periodicals of Barcelona.

We reproduce below only its conclusions, because by publishing the entire report we would have to repeat much concerning the technique, morphology and action of the comma bacillus which we have already said in other parts of our book, although subsequent researches have caused us to correct some details.

#### CONCLUSIONS OF THE REPORT OF THE ROYAL ACADEMY OF MEDICINE OF BARCELONA.

(1) That the micro-organism described by Finkler and Prior and found in the sporadic cholera is not the same as that discovered by Koch in Asiatic cholera.

(2) That the comma bacillus, as described by Koch, represents only one of the phases of a micro-organism whose morphological evolution is quite complex.

(3) That the comma bacillus of Ferrán, obtained in Marseilles and cultivated in Tortosa and Barcelona, is identical with that of Koch in every respect; and that of Van Ermengem is identical to both, the three being the same.

(4) That the careful and conscientious investigations of Ferrán, tested and confirmed as previously mentioned by the commissions, prove without any doubt that this parasite in its complete morphology passes through the following phases: Spiral filament, appearance of spores in the latter, escape of these, growth of the same and differentiation of its contents, conversion into a muriform body, escape of a cloud of protoplasm, condensation of the latter, and the formation of an extremely fine spirillum, which is the thallus of new vegetations.

(5) That, moreover, in certain stages of the culture there are constantly bodies called *ögonia* and *öosphera* whose rôle should be further studied, as also other less constant forms which certainly are not extraneous to the microphite.

(6) That independent of every other influence, the injections of the fluid cultures have a marked pathogenic action, frequently mortal and even rapidly so, without either the symptoms or the autopsy suggesting any other affection than cholera.

(This conclusion was modified in the following manner:

“(6) That aside from every other influence, the injections of the liquid cultures are followed by a marked pathogenic action, frequently and rapidly mortal; and by reason of having to do with an inoculation of cholera products, and by reason of the phenomena observed during life and after death, it is justifiable to admit an analogy with Asiatic cholera.”)

(7) That in this infection produced by means of hypodermic injections the gastric intestinal disturbances and the symptoms dependent upon them are wanting, as they ought to be; the symptoms are those of rapid infection with a very accentuated coldness, convulsive apparently painful movement and cyanosis, in guinea-pigs.

(8) That in the blood a micro cythæmia is constantly observed, the more accentuated the greater the dose, besides coci and disks of various sizes, although not well recognized. This blood reproduces in bouillon and in gelatine tubes or plates, all the forms which characterize the micro-organism in question, and which are themselves propagable through interminable series of cultures.

(9) That in man all the phenomena occasioned by hypodermic injection exist, but a lesser quantity of the injection material causes slighter development and less violence.

(10) That these facts have been corroborated in large part by Van Ermengem (*ögonia*, *öosphera* and the symptoms following the inoculation with much serious diarrhoea, in the cases of injection into the duodenum—diarrhoea in which there are comma bacilli, capable of being cultivated in series, the forty-second having been reached in guinea-pigs, always causing death).

(11) That from all the facts related the scientific conviction follows that the micro-organism which produces cholera has been discovered and described, which conclusion well established by the labors of Koch alone, and supported by many considerations, has to-day received new confirmation.

(12) That from the point of view of the commission, there is no great importance in determining the taxonomic situation of the micro-parasite, since in order to resolve this part of the question certainly and definitely, it is necessary to closely study the forms in those cultures not yet sufficiently known, and to fix more definitely than is at present possible the classification of the cryptogamic plants.

(13) That by diminishing the dose, or attenuating the activity of the cultures through the action of oxygen or of time, we become possessed of a liquid of less intense action, which in spite of very insignificant disturbances leaves the guinea-pigs insusceptible to the effects of greater doses or of more virulent cultures.

(14) The same experiments attempted upon man, but in smaller doses, prove that prevention is as evident as in the animals.

(15) That these deductions, as respects prophylaxis, create the hope that the means of avoiding cholera has been discovered; but the discovery can not be affirmed without testing it in an epidemic.

(16) That various substances markedly noxious to man do not retard in the slightest degree the evolutions of the microbe, and callabar bean even favors and stimulates them very decidedly.

On scientific grounds the commission has nothing more to add. We have endeavored to be brief, although the subject is so vast, and we have sought to let the facts speak rather than words.

But before closing the Academy would add:

(1) That an expressive communication has been sent to Dr. Ferrán in which is manifested the high estimation in which the Academy holds his special knowledge in microbiology; that they nominate him corresponding member, since by his residence outside of Barcelona he can not be an active member; and that they have handed to him a gold medal with a personal inscription and the date of the day upon which they voted the report.

(2) That they strongly advise the municipality of Barcelona to furnish Dr. Ferrán the assistance necessary for the prosecution of his labors, that he may travel if necessary in search of new facts, and that if it is possible they may create a special laboratory under his direction in order that he may continue his studies in this or other diseases, etc.

(3) That it being impossible to nominate as a corresponding member of the Academy his collaborator in these discoveries, Dr. Pauli, because he does not meet the necessary conditions, the corporation manifests towards him its regret for not being able to do so, as also the esteem in which the Academy holds his valuable and intelligent co-operation.

For the satisfaction of all and as a proof of having performed our duty the commission states that all the objects have been sterilized at once after they became useless for study, and that the dead guinea-pigs were as a measure of precaution immersed in a concentrated solution of corrosive sublimate and immediately afterwards destroyed by fire.

All of which we have the pleasure of submitting for the approbation of V. S. I., in fulfillment of the charge which was placed upon us.

Dr. L. CARRERAS.

Dr. J. GINÉ.

Dr. E. BERTRAN.

Dr. H. ROIG.

Dr. SOLER.

Dr. R. RODRIGUEZ MENDEZ, *President*.

BARCELONA, *March* 11, 1885.

In addition to the foregoing conclusions we think it advisable to publish the clinical observations which accompany the report of the Royal Academy of Medicine and Surgery of Barcelona, because they refer to the individuals inoculated for the purpose of the investigations of the commission of this Academy.

#### 1.—INDIVIDUALS INOCULATED WITH THE ARTIFICIAL CULTURES OF THE MICRO-ORGANISMS OF CHOLERA.

(a) The following gentlemen received a half a cubic centimeter of the culture in the postero-inferior part of each arm:



(Here follow the names of six physicians, of four students of medicine, and of three others.)

(b) Two physicians (names given) received a half cubic centimeter in a single arm.

(c) Two physicians and two others (all the names given) were inoculated by the gradual method, without occasioning general symptoms.

## 2.—INDIVIDUALS INOCULATED A SECOND TIME.

Six physicians and two others (the names given) were subjected to a second inoculation.

The second injection made with the above named culture did not produce any of the general symptoms to which the first gave rise, and the local phenomena were markedly lessened.

## 3.—CLINICAL HISTORY OF THE INDIVIDUALS INOCULATED FOR THE FIRST TIME.

*Observation 1.*—The 23d of February, 1885, I submitted to inoculation of the cholera microbe. At 5 o'clock p. m., on the said day, Dr. Jaime Ferrán y Clua performed upon me a hyperdermic injection of the cholera virus—half cubic centimeter—in the posterior part of each arm. I noticed nothing until about three hours after, when a severe pain in the site of the injection reminded me of the operation; pain which gradually increased until the free action of the superior extremities became impossible, and which radiated to the tendinous insertion at the olecranon of the three heads of the triceps.

At 11 p. m. I retired to bed, and after a slight chill I experienced a genuine fever; the temperature went up at least a degree and the pulse reached a hundred. Aching of the bones was general; slight pain in the head, abnormal thirst somewhat intense, urinary secretion slightly increased, great agitation, and complete insomnia.

At 8 in the morning of the following day, the 24th, I arose, the previous symptoms, however, continuing; and finding that this condition did not prevent me from devoting myself to the duties of my profession, I passed the whole morning prostrated and in a better condition to keep the bed than go into the street.

At 1 o'clock p. m. of the 24th I dined, but with little appetite, and during the afternoon; at 8 o'clock p. m., the general symptoms somewhat abated and rapid defervescence began at that hour. At 10 o'clock the fever had almost entirely disappeared, so that when I retired I soon fell asleep and passed the whole night in a profound and quiet slumber.

On the 25th, upon rising, there were no remains of the inoculation except the pain in the arms, which continued to diminish gradually until the forty-eighth hour from the inoculation, when it entirely disappeared.—Prudencio Sereñana, Barcelona, March 11, 1885.

*Observation 2.*—Inoculated with a hyperdermic syringe in the posterior part of both arms. [Here are succinctly described the principal symptoms of the inoculation.] At 3 o'clock I began to feel a severe pain in both arms, which progressively increased until they became stiff; simultaneously with this pain a general prostration, intense cold with involuntary chattering of the teeth, with marble-like coldness in the hands and feet, frontal headache, nausea, two movements of the bowels, the last semi-diarrhoeal (it should be remarked that I usually suffer from constipation, not having a movement oftener than every three or four days); acceleration of the pulse to 96 beats; these symptoms, which I allow myself to denominate concentration, were augmented up to twelve hours after the inoculation, and I found it necessary to go to bed on account of some dismay; this condition remaining a half hour, a reaction was not expected, and this corresponded to the first period; intense fever developed; the pulse increased to 125 pulsations, the temperature to 39° C.; the headache became more intense; great thirst; loss of sense of taste; light delirium. The fever lasted from twelve to eighteen hours from the inoculation, and, this terminated, there only remained, according to my recollection, the pain in the arms and the prostration, which finally disappeared in five days after the inoculation.—Ignacio Llorens, Barcelona, March 11, 1885.

*Observation 3.*—At 11 o'clock in the morning of the 3d instant, Dr. Jaime Ferrán injected by means of a hyperdermic syringe a half cubic centimeter of pure culture in each arm.

The pain which the injection caused was slight in the right arm, and a little more sensible in the left; however, it did not long persist, for already at 2 o'clock (a little more or less) it had

completely disappeared; observing no special phenomena, I was able to eat with the usual appetite at 2 p. m.

A little after, the pain in both arms re-appeared, gradually increasing in intensity until movement of them was extremely difficult; these painful symptoms were re-enforced by some general troubles (frequency of pulse, general malaise, headache, aching of the bones, etc.). I had to abandon my usual occupations and keep to the bed.

These phenomena reached their height at dusk and persisted during the whole night, repeated chills, nausea, copious perspiration, slight cramps in the calf of the right leg presenting themselves; there was no sign of diarrhœa.

All the above-mentioned symptoms persisted, although with a very slight degree of intensity, during the whole of 4th; nevertheless it is right to admit that the pain in the arms was very severe, movement of them being almost absolutely impossible, on account of which I was obliged to remain in bed.

Upon the following day a diminution of the symptoms was marked; in fact the chills, nausea, cramps, and sweating had disappeared, and the frequency of the pulse, headache, and local pains at the site of the injection had diminished.

Little by little the said phenomena disappeared, and I was free of them on the 6th, excepting a slight difficulty in certain movements of both arms, which persisted almost during the whole of the 7th.

Thus are briefly related the effects which the inoculation of the comma bacillus produced with me.—Dr. Farriols Anglada, Barcelona, March, 1885.

*Observation 4.*—At 11 o'clock a. m. of the 4th of March, 1885, a half a cubic centimeter of the fluid culture of the microbe of cholera was injected into each arm of the undersigned. Pulse normal, 76 per minute.

Pain, as in every hypodermic injection, increased little by little, and was already somewhat intense at 3 o'clock in the afternoon, at which hour it had extended to the elbow and to the upper third of the fore-arm, but was not felt in the fibro-articular tissue of the elbow, except in the subcutaneous cellular tissue; headache, which, without being very intense, was rather troublesome by reason of its persistence and duration, for I was not free of it until 11 a. m. of the following day (the 5th), upon which it began to disappear quite rapidly, there being substituted for it a heaviness of the head, which lasted the whole day.

At the same hour when the headache began, I commenced to feel somewhat cold all over the body, and at 7 experienced slight chills. Pulse, 108 per minute.

Nevertheless my appetite did not leave, for I had dined at 1 and taken supper at 8, as upon other days.

At 9 at night the chills returned, and, being already in bed, they ceased in a quarter of an hour, a very intense heat being substituted for them, which caused me to move continuously, although the pain in the arms protested against every movement. The pulse was 120 to 130 per minute. This lasted all night, although it remitted somewhat at 3 o'clock in the morning.

I could not sleep more than a short snatch at 4 o'clock in the morning—insomnia, which also appeared to me might be due entirely to the pain in the arms, if not indeed to the headache.

During the whole of the night (from the 4th to the 5th) lips very dry, tongue pasty, covered by a light coat; some thirst, but it was more owing to necessity of moistening the lips than a desire to drink.

Urine scanty, only a quarter of the normal quantity; color a little increased, and no deposit of any kind after cooling. I do not consider that this scarcity may be due to the fever, because I had already noted it the same evening of the 4th, in which there was solely a slight acceleration of the pulse. Neither sweating nor diarrhœa. Was it due to the action of the active principle of the culture upon the medulla?

On the morning of the 5th a passage somewhat diarrhœal; scarcely any fever; the pain in the arms was continued with much intensity, and the headache, as already mentioned, began



to diminish in a notable degree at 11 a. m., and at 1 p. m. there remained only a heaviness of the head, which lasted all day.

During the night of the 5th to the 6th there was no pain in the arms. I slept soundly all night.

Afterwards there remained nothing more than the pain in the arms, which diminished to such a degree that by the third day I could already move them with some freedom, and by the fifth it had disappeared entirely, a slight itching only remaining, which lasted up to to-day.—Quirico J. Eapadaler, Barcelona, March 11, 1885.

*Observation 5.*—The phenomena which I observed after having myself inoculated with the comma bacillus were the following:

In three hours from the inoculation I experienced at the site of the small wound a continuous and sharp pain, which increased in a gradual manner, and which reached its maximum of intensity between four and five hours; localized at first in the thoracic members it was not slow in extending over the whole body, but was always more intense in the first location, and was accompanied by a muscular relaxation, which made it impossible for me to put forth any strength.

In the nervous system I observed, or I thought I observed, that there was some diminution of general sensibility; very marked insomnia, which continued until the morning of the following day.

At the same time that the pain began I experienced intense and frequent chills, which recurred at short intervals, accompanied by profuse perspiration until 4 o'clock in the morning. The chills ceased three hours after they began.

In the digestive apparatus nothing abnormal observed.

My companions said that they had noticed that my face was swollen.

All the phenomena were diminishing from the hour indicated, and in such a manner that in forty-eight hours my condition was normal.—Miguel Nebot Mesquida, Barcelona, March, 1885.

*Observation 6.*—It was about 7 p. m. when Dr. Ferrán vaccinated me. At 9 p. m. I already felt uneasy; a heaviness in the arms which troubled me much, until at 10 I could not do anything with them, such was the pain which they caused me, it being much greater when there was any movement, for I could not even extend them. At 11 p. m. I experienced a palpitation of the heart, which only disturbed me by the darting pains which it from time to time occasioned me, although they were not very severe; at the same time respiration was a little difficult, there being a tendency to more profound inspirations; besides all this the pains in the arms went on increasing, and at the same time I counted my pulse twice, finding the beats 86 per minute each time.

At half past 11 p. m. I went to bed, sleeping until 1 a. m., when I awoke (which does not happen to me usually), experiencing until 5 a. m. a slight insomnia, quiet and comfortable while I made no movement, at which hour I again went to sleep.

It is not to be thought of that my inability to sleep was due to the fear of having been injected with comma bacilli, for I was quiet, and quite gratified at having the honor of being among the first vaccinated in Barcelona. I make this declaration in order to remove the idea that the cause of insomnia was fear, for there were many, including Dr. Ferrán, who asked me that question.

I remained all the morning in bed, on account of being unable to make any movements of my arms without great pain, and on account of my whole body being bathed in a copious warm perspiration; I had no fever, as a friend told me, a third-year student of medicine who had visited me. In the afternoon I arose, dined with my usual appetite, and passed the rest of the day comfortably, excepting that at 5 p. m. I was seized for a few minutes with chills and pains in the arms, which did not cease, not being able to perform adduction or abduction with them, for I thought that the axillary glands were infarcted. I passed the whole night in slumber, and the following day all the pain somewhat diminished.

During this term I had experienced neither vomiting, diarrhoea, nausea, or cramps; in

view of these latter statements I would ask if predisposition for this disease was absent.—Juanet Cardona, Barcelona, March, 1885.

*Observation 7.*—At 3 p. m. of the 11th of March, 1885, being in the vaccination hall of Dr. Juan Giné y Pentagas, Dr. Jaime Ferrán y Clua injected into the lower posterior third of each arm one half cubic centimeter of his culture of *peronospora-Ferrani*.

Subsequently, in order to try the experiment for the first time, whether there might be antagonism between the two viruses, I inoculated myself in the anterior superior third of each arm with vaccine lymph.

There were present Dr. Prudencio Serañana; the sons of Dr. Giné; a student of medicine, Mr. Eduardo Padros; and some other alumni of the same faculty.

Up to 6 p. m. I observed nothing else than a very slight pain produced by the puncture of the hypodermic needle; but from that hour I commenced to feel a certain heaviness in the arms, rise of temperature, which went on increasing up to 7 p. m., at which hour the pulse was 96 per minute.

At 8 p. m. I observed, and it seemed strange to me, a marked fall of temperature, followed by coldness in the extremities; the pulse was 80 per minute.

At quarter past 8 p. m. I experienced chills, and the pulse fell and became almost thready. I ate my supper as usual.

At 9 p. m. the temperature again rose; the pain in the arms became intense; I again felt pain in the stomach and intestines, which had been already experienced; at 6 a. m. I had a slight headache, the eyes hot, general malaise, pulse 108 and thready.

At 10 a. m., as usual, I took coffee.

At 10:30 a. m. the temperature had diminished slightly, the pulse being 100; the general malaise continued; the pain in the arms increased and I noted the return of pain in the intestines, but without desire to defecate.

At 11 p. m. the same symptoms with chills, with pulse lowered and headache.

At 12 o'clock noon the same symptoms, general malaise, congestion of the eyes and head, the face much flushed, much drowsiness, and I experienced much thirst and drank much.

I went to bed and slept profoundly until 8 p. m.; I turned again to sleep, but I arose at 10 p. m. to look around, for the pain rendered my arm useless; the chilliness, the general malaise, and the fever had disappeared; only the pain in the thoracic extremities remained, and I experienced a sense of debility as great as that observed in the convalescence from a severe disease.

At quarter past 11 p. m. the pulse was 88 and thready.

At half past 11 p. m. Drs. Giné and Luis Carreras examined my blood with the microscope they saw a few very small granules.

At 1 o'clock p. m. of the 12th, general malaise without chills, the arms painful, pulse 84, a subepidermic stinging pain in various parts of the body.

At 5 p. m. same symptoms continued with increase of temperature; pulse 108, and very slight intestinal pains.

At half past 6 p. m. the same symptoms continued; I had no appetite, nor thirst, nor desire for tobacco.

At 11 p. m. pulse 96, but the temperature had notably fallen.

I went to bed and noticed that I had hyperæmia with considerable injection of the conjunctiva; inflammation of the arm.

At the puncture made during the vaccination nothing particular was noticed; it was very natural, since it was only thirty-six hours since the introduction of the lymph.

I arose at 9 o'clock on the morning of the 13th, and felt perfectly well; I was able to clothe myself alone, and the pulse marked only 68 per minute.

At 3 o'clock in the afternoon, I continued in good health and the pain in the arms was scarcely perceptible.—Claramount y Furest, Barcelona, March 13, 1885.

*Observation 8.*—Eduardo Bertrán Rubia, aged 46; medium height; ordinarily vigorous;



functions normal, without preceding disease or diathesis of any kind. Submitted himself, February 23, 1885, to a hypodermic injection of a pure culture of comma bacilli.

The culture was in bouillon (the source of the bacilli, Dr. Van Ermengem of Brussels); it was rich, at the maximum of its virulence, recently removed from the incubator (this clinical history is another proof; which demonstrates that already in the control experiments I employed the culture at its maximum virulence, a fact which those who seek for the supposed secret of attenuation should have fixed in their minds, and which was published in the report made by the Royal Academy of Barcelona); previously examined by the microscope, it was ascertained that the culture was composed of comma bacilli or of spirilli, without mixture with any other species of germs or living elements.

The syringe and its canula were sterilized with scrupulous care; quantity injected, one-half centimeter; region, the posterior portion of the left arm at the juncture of the lower third with the middle third; time, 1 p. m.

At 3 p. m. pain began in the region of the puncture; gradual increase of tension of the tissues; local increase of temperature.

At 7 p. m., the pain is tensive and lacerating; tumefaction and increased heat in the part considerable; much difficulty in the movements of the arm. The left hand began to grow cold at the same time that the local symptoms of inflammation rapidly increased.

At 8 p. m., chills, malaise, uneasiness; slight coldness of the extremities, with some cyanosis in them; soon there began a marked febrile action which increased until dawn, when defervescence set in, terminating in a genuine stage of sweating. Altogether it closely resembled an attack of intermitting fever. The extremities always continued cold, particularly the left. At the beginning of the hot stage I had a profuse diarrhoeal stool, but without any choleriform character; maximum temperature during the attack 39.5 C.; pulse 120 (taken at the radius).

During the whole of the following day the local symptoms continued in all their intensity, even with somewhat increased intensity. At the same hour as of the previous day, and in the same manner and with an equal duration, an access of fever was observed, but without diarrhoeal stool, and with less pyretic intensity.

Maximum temperature 38.5 degrees C; pulse 110.

Upon the third day I had no febrile attack.

Microscopic examination of the blood, on the second day, showed the infection of that humor by considerable numbers of granules; microglobulie was much less perceptible than in other persons inoculated at the same time with the same culture.

The local symptoms continued, but with gradual although slow diminution during eight days (which is exceptional). Resolution of the infarct was complete, and without suppuration, as in all other cases under observation.

During the personal observation, whose details I have given in their order, I did not change my usual food in any manner, nor my duties nor habits, neither did I take any medicine; I desired not to alter or to disturb the spontaneity of the phenomena observed.—E. Bertrán y Rubio.

*Observation 9.*—The 14th day of last February, at 4 o'clock in the afternoon, I submitted to inoculation with microbes of Asiatic cholera, the hypodermic injection being performed by Dr. Ferrán at the humeral insertion of the right deltoid, and received a half a cubic centimeter of a culture of the comma bacillus.

I did not permit the same operation upon my left arm because of the sharp pain felt upon the introduction of the canula of the syringe, which in its entrance, perhaps, wounded some nervous filament. This pain disappeared in a quarter of an hour.

At 5 p. m., or an hour after performing the injection, I began to feel in the external and posterior part of the right arm a severe pain, increase of heat, and a sensation of induration of the cellular tissue, symptoms which were accentuated momentarily until I was obliged to

hold the arm fixed, the fore-arm semi-flexed and the hand resting upon the breast in order to avoid every movement and not to exasperate the pain.

At the time of the injection my pulse beat seventy-two times per minute, as noted by Drs. Juan Giné and Prudencio Sareñana. At a quarter to 6 p. m. Dr. Giralt counted ninety-four beats to a minute of the radial pulse, and at that hour a slight headache began.

Notwithstanding this semi-abnormal condition I ate a hearty supper that night and went to bed, without noticing anything else noteworthy, but was slow to fall asleep, waking from time to time, which is not my custom, being besides prompted to lighten the bed covering on account of the great heat which I felt.

On the following day, the 15th, all the general symptoms had disappeared, but not the local pain, which, at times severe, mild at others, had extended over the whole posterior part of the arm, and whenever I attempted extension of the fore-arm I felt it as far as the insertion of the triceps in the olecranon. This pain lasted, decreasing each day, for five days. At the invitation of Dr. Ferrán, I submitted on the 4th instant to a second inoculation, which did not occasion other phenomena than the local ones previously described, but these were of less intensity and less duration, not preventing me from undertaking a long journey that same day.—Eugenio Jaquez, Barcelona, March 12, 1885.

*Observation 10.*—On the 5th of March, at 11 a. m., Dr. Ferrán inoculated four drops into me, two in each arm, of the attenuated virus of cholera. During the first six hours I noted nothing, but at 5 p. m. besides the liveliest local pains, I experienced a slight general malaise, rise of temperature but little pronounced, and loss of appetite to such an extent that I could scarcely eat supper. The following day, after a night comparatively tranquil, I was well, but by the afternoon the same slight fever preceded by chills recurred.

On the third day the pains in the arms diminished. On the fourth they disappeared, and no infarct appeared at the site of the punctures.—Antonio Formica-Corsi, Barcelona, March 13, 1885.

*Observation 11.*—On the 5th of the present month my friend, Dr. Ferrán, of Tortosa, gave me a hypodermic injection in each arm, of two drops of his attenuated culture of the peronospora barcelonæ, for the prevention of Asiatic cholera.

The operation took place at 11 a. m., and at 3 p. m., lying down in my study, I felt, although I did not expect it, a certain general malaise, which caused me to count my pulse, which was beating some ten or twelve times more frequently than normal. I did not measure the temperature for I did not then have my thermometer at hand, but I presume that it was a degree or a little more above my normal, which is  $36^{\circ}.5$  C. I experienced some anxiety and a sensation which suggested localized chills in the head or neck. These phenomena did not prevent me from continuing my studies, for my head remained clear, and they disappeared three hours later without leaving more traces than a marked anorexia, which persisted two days.

The local phenomena were few: lively pain the first and second days, tolerable the third, insignificant the fourth, and none at all on the fifth; no induration of the subcutaneous cellular tissue with the exception of some slight swelling and increased firmness of the external portion of the triceps muscle, due without doubt to the puncture of the needle of the syringe.

I noted nothing afterwards which I could conscientiously attribute to the slight infection produced.—M. Cabis y Balmaña, Barcelona, March 13, 1885.

#### 4.—CLINICAL HISTORY OF THE INDIVIDUALS INOCULATED A SECOND TIME.

*Observation 1.*—On the 4th of March, or nine days after the first inoculation, Dr. Ferrán injected at the same places, that is, in the posterior portion of each arm, and by the same method a half cubic centimeter of cholera virus. The injection was performed at 11 o'clock in the morning, and it did not awaken in my economy any general phenomena, all of the functions continuing to be performed with the most perfect regularity. At night I slept tranquilly.

Not so with respect to the local phenomena. At the points of puncture from the moment



of the injection a severe pain began, with exacerbations upon the slightest movement, pain which was increased in intensity during the space of twenty-four hours, and gradually subsided in as many more.

The site of the inoculation remained somewhat painful, and even to-day, by pressure upon the lower part of the triceps, I feel a disagreeable sensation which reminds me of the site of the punctures.—Prudencio Sarenaña, Barcelona, March 11, 1885.

*Observation 2.*—The 14th, 15th, 16th, and 17th of the month of March passed without any development from the vaccine lymph, which, as I have already said, I inoculated myself with on the 11th, at the same time as the inoculation of a culture of the *peronospora ferrani*.

On the 18th, in the histological laboratory of Dr. Carreras, the naturalist, Dr. Ferrán re-inoculated me with the microbe of cholera, injecting a half cubic centimeter of his *peronospora* into the posterior aspect of the fore-arms.

According to custom, the distinguished micro-biologist injected an equal dose of the same culture into my confrère and friend, Edouardo Padros.

This person, who was inoculated for the first time, experienced something similar to what I perceived in myself after my first inoculation with the *peronospora ferrani*.

I, on the contrary, did not experience anything else than a sharp pain in the fore-arms, which prevented me from working for a day.

On the 22d the vaccine lymph had not yet given any signs of life. The incisions were completely cicatrized. Was it that the necessary conditions of life were not present? I think so. For among all of my companions who vaccinated themselves on that same day the same happened to them.

With respect to this, however, it may not be believed by the single experiment performed on myself that the virus of cholera and that of vaccinia may be antagonistic.—Luis Claramunt Furest, Barcelona, March 27, 1885.

*Observation 3.*—See the last paragraph of observation 9.

*Observation 4.*—On the 13th of March, eight days after the first inoculation, Dr. Ferrán inoculated me with eight drops (double the quantity first given) of the choleraic virus, half in each arm. The inoculation was performed at quarter after 4 in the afternoon, two hours after having dined. Notwithstanding this I only noted a slight pain in each arm in an hour and a half, but especially in the right, which was also more painful at the first inoculation; this pain increased without acquiring much intensity, for it was easily bearable at 6 o'clock. I observed no other phenomenon, for I supped heartily with my usual appetite, and experienced no general symptoms. To-day, the 14th, upon rising I scarcely felt any remains of the pain in the arms.—Antonio Formica-Corsi, Barcelona, March 14, 1885.

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#### REPORT ON THE ATTEMPTS AT CHOLERAIC VACCINATION MADE IN SPAIN BY DR. FERRAN.

By BROUARDEL, CARRIN, AND ALBARRAN.\*

MR. MINISTER: Within the last few weeks great attention has been excited by the attempts at anti-choleraic inoculation made in Spain by Dr. Ferrán. The medical and political press have reproduced and discussed the information obtained regarding his method, as well as the results of the published statistics. A few persons have made lively criticisms, while others find in these attempts a legitimate hope justified, namely, that of applying to certain infectious diseases peculiar to man the prophylactic methods employed with such success by M. Pasteur against some infectious diseases peculiar to certain species of animals and against others common to both man and animals.

Among the Consulting Commission of Hygiene and the members of the Academy of Medicine we have met with the expression of these divers sentiments. Some physicians of the South had written to several of us to ask if there was sufficient justification to prepare to practice vacci-

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\* Presented to the French Minister of Commerce by Drs. Brouardel, Charrin, and Albarran.—Bulletin de l'Académie de Médecine, No. 27, Séance du 7 Juillet, 1885.

nation according to the method of Dr. Ferrán. A commission of the Royal Academy at Barcelona had given a favorable opinion of the morphology described by Dr. Ferrán without venturing an opinion on the value of preventive vaccination, too little practiced at that time. The drift of opinion was clearly in favor of the attempts of Dr. Ferrán.

On the 16th of June the special choleraic Committee of the Consulting Commission of Hygiene was assembled, and it unanimously decided that none of its members had obtained sufficient information on the methods adopted and results obtained by Dr. Ferrán to decide whether these inoculations could be authorized in France; it also unanimously decided that there was justification for sending a commission to Spain to make an investigation. One of the members, M. L. Pasteur, remarked that in such an obscure question as that of inoculation of weakened virus a preconceived judgment would be unwise, that even if the investigation demonstrated that the disease produced by Dr. Ferrán's inoculations should not be attenuated cholera, one could not without investigation affirm that these inoculations, whatever might be the nature of the injected liquid, are incapable of producing immunity against cholera.

The next day, Mr. Minister, I had the honor to address you a report, from which I reproduce the following passages :

“JUNE 17, 1885.

“MR. MINISTER: Within the last two months Dr. Ferrán has been making in Spain attempts at a new mode of preservation against cholera—that of choleraic vaccination. It is true that there is still much obscurity regarding the nature of the liquid injected, its effects, the innocuousness or the harmfulness of the inoculation. Nevertheless, the statistics published have been up to the present pretty favorable.

“It is possible that the commission may have to declare an opinion on the value of these preventive inoculations; and if the cholera invades France again, public opinion will not pardon us if we have not decided upon the efficacy or non-efficacy of choleraic vaccination.

“M. Bouley, president of the Academy of Science, requested you to send to Spain one of his pupils, Dr. Gibier; you immediately accorded to our young *confrère* the mission that he sought.

“But the responsibility which rests upon the Consulting Commission of Hygiene and its president as to the prophylactic measures to be taken to prevent the invasion of France by foreign diseases and to limit their spread after invasion, imposes the duty of judging for themselves of the value of the measures to be recommended for future employment.

“If, Mr. Minister, you are of this opinion, I have the honor, with the accord of the Consulting Commission on Hygiene, to request that you may have the kindness to direct a commission of three persons to proceed to Spain and gather information on the nature of the vaccination liquid employed, the effects of the inoculation, and the degree of prevention.

“P. BROUARDEL, *President*.”

You did, Mr. Minister, the same day authorize a scientific commission to proceed to Spain to study the attempts at choleraic vaccination undertaken by Dr. Ferrán.

You designated as a member of that commission the president of the Consulting Commission of Hygiene, M. Roux, of the Normal School laboratory, and M. Albarran Joaquin, resident physician in the hospitals of Paris. For reasons explained later, Mr. Roux felt compelled to decline the mission, and was succeeded by Dr. Charrin, chief of the laboratory of general pathology of the faculty of medicine.

After supplying ourselves with the materials necessary for the accomplishment of the mission with which we were charged, in order to test the experiments of Dr. Ferrán, and institute new ones, if it seemed worth while, we left Paris the 27th of June.

On arriving at Valencia we placed in the hands of Dr. Ferrán the personal letter of Mr. Pasteur.

Here is a copy of that letter :

“PARIS, *June 26, 1885.*

“DEAR DOCTOR: Our minister of commerce has decided to send to Spain a commission to follow your operations and learn the results. I greatly regret not being able to accompany



it. But you will be satisfied with its composition. Dr. Brouardel, who is in charge, and whose labors and eminent abilities and judgment are known to you, is accompanied by two very distinguished young doctors, thoroughly up in microscopic studies, Messrs. Charrin and Albarran.

"What you will particularly appreciate is the great spirit of impartiality which animates them. You will easily realize this when I add that Dr. Roux, of my laboratory, at first intended to constitute part of this commission, but he has been scrupulous to such a degree as to decline the honor, because he did not desire it to be said that the commission included a man who had formed an opinion regarding the question of cholera. Mr. Brouardel yielded to the scruples of Dr. Roux, scruples, in my opinion, exaggerated, but that only proves the desire here to go to you for the purpose of studying everything without previous convictions.

"You will receive these gentlemen with a desire to lay the whole truth before them.

"For my part, this is how I look at the question: You are the object of the raillery of some, the hostility of others, and the infatuation of a large number. You are reproached with errors committed concerning the morphology of the bacilli. They say that you have with your cultures succeeded in killing animals easily by hypodermic injections, which in other hands has been very difficult, exceptional, even impossible. All that, in my opinion, is of very little importance. They commence already to recognize that you have observed facts of morphology which escaped others who have studied the bacilli of Koch, as well as Koch himself. What is of the first importance to be known is, whether you prevent the cholera in the inoculated persons.

"Help our mission to arrive at a decision on this subject. You can do that by enabling them to form their own statistics. You can place under their eyes the proofs of prevention through the effects of your inoculations, both on man and on animals.

"Nevertheless, although rigid statistics are desirable, I entreat you particularly, besides the preventive experiments that I speak of, to submit your cultures to the examination of these gentlemen, and, if possible, to send a few to my laboratory by their hands.

"Dr. Roux is not only a good judge of this matter, but he has perfected microscopic photography to such a point that his photographs are of great clearness, even at 1500 diameters.

"Accept, again, dear doctor, the assurance of my high consideration and my best wishes for the success of your enterprise. The question of attenuated virus is yet so mysterious that no one is justified in throwing stones at you because of their preconceived ideas or *à priori* arguments. Facts alone must be invoked in order to pass judgment upon your method.

"I have the greatest confidence that our French mission, through your kindness, will be able to unravel the truth."

"L. PASTEUR."

Immediately after the arrival at Valencia, on the morning of the 30th of June, we proceeded to the house of Dr. Ferrán. We gave him the letter from Mr. Pasteur. After having read it, Dr. Ferrán declared to us:

(1) That he refused to explain the process he employed to produce attenuation of the cholera virus;

(2) That he authorized the commission to examine *in his laboratory* his vaccinal liquid, but that he objected to a single drop leaving his laboratory or being carried away;

(3) He proposed to the commission to obtain for themselves matter from choleraic dejections; to prepare from it a pure culture, and then give him a flask of it thus prepared, this flask to be placed in a box sealed with wax. For three days this flask should remain in the hands of Dr. Ferrán, the commission not to be allowed to watch his operations. Finally, the flask should be given back to the commission; then in its presence and with this liquid vaccinations should be performed.

During the same interview, to the objections that we presented Dr. Ferrán made the following replies:

"I wish to preserve my secret; in giving it to you, I see what I give you, but I do not see what guarantee you give in return."

Mr. Ferrán compared himself to a manufacturer who, having found a process for preparing sulphate of quinine at 25 centimes a kilogramme, would not be obliged to divulge his mode of preparation.

He finally asked us to propose to the minister of commerce to negotiate with him concerning the conditions under which he would surrender his secret. We naturally refused to undertake any such a mission. We were, we told him, on a scientific mission and not a commercial one.

After this first interview we retired to deliberate; the conversation having been in Spanish, and two of us not understanding that language, some of the details might have been poorly interpreted.

The deliberation was short; none of us had any hesitation; we could not accept the three propositions of Dr. Ferrán, even forgetting momentarily his strange responses.

We found ourselves in the presence of a doctor having a secret remedy and speculating by it. But what struck us most was the exceptional character of this remedy.

When a person devises a secret remedy it is to be supposed that its harmlessness, once established, the proprietor would not subject it to important modifications; is that the case here? Not at all. Those of us who are acquainted with the difficulties accompanying the preparation of bacterial cultures, the delicacy of the process, and the precision necessary during every stage of the operations, know that in order to produce a virus attenuated to a definite degree, numerous experiments, repeated efforts, are necessary. The principal point is to know whether the liquid remains a virus or has become a vaccine, and to obtain a regularity and permanency of the attenuation. Now, this constancy is so difficult to obtain that during his first years Mr. Pasteur himself encountered frequent deceptions. Who then can say, unless we know in all its details the mode of preparation of choleraic vaccine employed by Dr. Ferrán, that it will remain always the same?

These remarks appear to us all the more necessary because, according to the admissions of Dr. Ferrán, each new provision of vaccine requires a repetition of the process of weakening; that his weakened virus does not reproduce itself, but that each time we must go back to the source.

If the vaccine be not lasting will not modifications of it occur by accident? Now, it must not be forgotten that it is not animals that are inoculated; it is men. Is there among us a single doctor, having at his disposition the vaccine of Dr. Ferrán, ignorant of its mode of preparation, incapable to judge of its value, who would dare accept the responsibility of practicing or counseling anti-choleraic vaccination?

We thus had to judge of the value of a secret remedy; but although chemistry furnishes the means of testing and analyzing remedies, for this vaccine, on the contrary, there was no other proof than the results of inoculation itself. As a commission we could not accept the offer of Dr. Ferrán to verify what he proposed to show us, inasmuch as all the time the operation would be a mystery to us. Our mission was to decide whether the anti-choleraic inoculations of Dr. Ferrán could be authorized in France. Before seeing Dr. Ferrán we had, in common, determined upon a programme which can be stated in a few words: To follow step by step each of the operations of Dr. Ferrán from the collection from the choleraic dejections up to the time of the inoculations; to make all such control experiments and others that might be called for; then to perform ourselves the same operations frequently until we should arrive at identical and constant results.

We did not expect to be able to submit to the minister of commerce and the Consulting Commission of the Academy a final report as to the authorization in France of Dr. Ferrán's method of anti-choleraic inoculation until we had applied every test, submitted everything to the criticism of our colleagues, and then requested the *savants* to make a definite decision.

On the other hand, not desiring that any of the reasons upon which our judgment was based should be later the subject of dispute on the part of Dr. Ferrán, we decided to communicate to him the dispatches and letters that we addressed to the minister of commerce.

Having formed this resolution, we again proceeded to Dr. Ferrán's and, after vainly striv-



ing to persuade him to recede from his original refusal, we read the following declaration to him:

"The French commission, sent by the minister of commerce had for its object 'to go and study in Spain the attempts at choleraic vaccination undertaken by Dr. Ferrán.' The commission holds that, in order to appreciate the value of these attempts, all the processes employed by Dr. Ferrán to obtain the weakening of the inoculating virus must be communicated without reserve. It could not assume the responsibility of giving its approbation to this prophylactic method if there was a detail reserved in the process of culture and weakening. If Dr. Ferrán persists in his reservations, the commission will address to the French minister of commerce the following telegram:

"Dr. Ferrán refuses to explain the real processes by which he obtains his vaccinal liquid. To justify this refusal he invokes his personal interest. The scientific question, therefore, can not be solved.

"It remains only to test the results of the statistics (details by letter).

"This dispatch has been communicated to Dr. Ferrán. Please advise Dr. Pasteur of it.

"BROUARDEL."

Mr. Ferrán requested us to erase from the telegram the following phrase: "To justify this refusal he invokes his personal interest." He declared that he himself desired to explain the reasons of his refusal. It was then agreed that the phrase should be stricken out, that we should the next morning hand him a more explicit letter to the minister of commerce, and that Dr. Ferrán should add his individual reply to this letter.

Here are these contents of these two letters:

"JULY 1, 1885.

"MR. MINISTER: In a letter of the 17th of June, speaking for the special cholera committee, composed of members of the Consulting Commission, I had the honor to write you:

"'Within the last few months Dr. Ferrán has been making in Spain attempts at a new mode of preservation against cholera—that of choleraic vaccination. It is true that there is still much obscurity regarding the nature of the liquid injected, its effects, the innocuousness or the harmfulness of the inoculation. Nevertheless, the statistics published have been up to the present favorable.'

"I added that if later on France were again invaded by the cholera it would be the duty of the committee to be satisfied regarding the prophylactic value of choleraic vaccination and to be prepared to counsel or discourage its employment.

"By order you the same day, Mr. Minister, appointed a scientific commission to proceed to Spain to study the attempts at choleraic vaccination attempted by Dr. Ferrán, and you designated as members of this commission the president of the Consulting Commission on Hygiene and Messrs. Charrin and Albarran.

"Our eminent colleague, Mr. Pasteur, very kindly gave us a letter for Mr. Ferrán, in which he designated the particular points of the investigation. Mr. Ferrán had many times proclaimed his admiration for the discoveries of Mr. Pasteur, and we therefore thought that he would hasten to furnish to him whom he called his "master" the means of judging of the value of his own works.

"But such has not been the case. At our first interview Mr. Ferrán informed us that he particularly desired to preserve his secret method of attenuating the choleraic virus. He refused to give us a few cubic centimeters of his vaccinal liquid, taken at the moment of vaccination, to study alone and at leisure the character and nature thereof.

"The commission holds that it can not decide what is the value of the inoculations practiced by Mr. Ferrán if it does not know in every detail the process employed for the culture and attenuation of the virus, and if it is not possible to follow, itself, all the researches and experiments on animals that seem necessary. It could not give its approbation to this method and counsel its adoption if there should be details intentionally reserved and if the preparation of the attenuated virus should be kept secret.

"We have therefore informed Mr. Ferrán that his refusal brought an end to our mission.

"We have requested him to tell us why he did not wish to divulge the details of a process which, according to him, almost with certainty protects from the epidemic every person who submits to an inoculation; we have remarked to him that we do not know of a single instance where a savant has refused to render public from the day of putting it into practice any means of cure; we have observed to him that, admitting the value that he claims for his process, he could not with the aid of his assistants be able to vaccinate a kingdom, and that consequently in refusing to furnish to his colleagues the means of suppressing an epidemic, he assumed a terrible responsibility. He remained unshaken.

"We have vainly endeavored to discover the cause of his refusal. We have proposed to submit to him this letter, as also the dispatch that we had the honor to address you yesterday, and Mr. Ferrán will himself add the motive of his refusal. In proceeding thus, we avoid ulterior discussions on explanations which might be considered as personal to us.

"Be assured, Mr. Minister, of our sentiments of respect.

"P. BROUARDEL.

"CHARRIN.

"J. ALBARRAN."

#### REPLY OF DR. FERRAN.

"VALENCIA, SPAIN, *July 2, 1885.*

"To the MINISTER OF COMMERCE, *Paris.*

"RESPECTED SIR: In accordance with the high duties of your position, your excellency has appointed a commission, composed of Drs. Brouardel, Charrin, and Albarran, to study my preventive inoculations against cholera. Satisfied that I will receive from your excellency kind attention for the considerations that I desire to lay before you, I desire to give an account of my relations with the commission.

"This letter is accompanied by another from Drs. Brouardel, Charrin, and Albarran, that I deem it indispensable to explain in some essential particulars.

"The principal complaint addressed to the eminent consideration of your excellency by the doctors named is that I preserve the secret of the process of attenuating the choleraic virus which converts it into vaccine; and this needs to be explained, for, if in reality there is a reservation on my part, that reservation is conditional and can be easily justified. It is quite necessary, Mr. Minister, to be acquainted with the conditions of scientific life in Spain, and the conditions peculiar to this question, to appreciate at their full value the causes of my refusal.

"I begin by affirming my belief that in regard to my method of the *prophylaxis* of the cholera, there are comprised two separable and distinct matters—the one, that which really interests humanity, is the effect of choleraic vaccination; the other relates to the process of preparing the vaccine. The first includes a knowledge of the vaccine liquid in its composition, the nature and morphology of the comma bacillus which it contains in pure culture, the demonstration of the physiological effects which it produces upon man, conviction as to the harmlessness of the vaccination, and lastly, the study of the immunity they confer or of their prophylactic action.

"The second matter is completely independent of the first. After each one has assured himself that my liquid is nothing else than a pure culture of the cholera microbe, prepared after the Pierre Miquel process, he has a perfect knowledge of its nature; as perfect as any doctor can have of the nature of sulphate of quinine or of chlohydrate of morphine which he employs without knowing the process by which the chemist has obtained these salts. And this has all the greater force, since *I do not refuse to allow microscopic and chemical examination of my vaccine liquid in my laboratory*, which has been done by the commission appointed by the Spanish Government to inspect my labors, that commission being obliged to admit that my liquid contained no element foreign to a pure culture of the *comma-bacillus* in bouillon. There is more, Mr. Minister, and I particularly call the attention of your excellency to this: I invited Drs. Brouardel, Charrin, and Albarran to themselves collect comma-bacilli from chol-



eraic dejections, and from them to prepare cultures in bouillon of their own preparation, and to confide this bouillon to me in a flask sealed with wax, in order that I convert it into vaccine which should be used in inoculating persons. After that, then, what most interests the world is to know whether the inoculations practiced with this vaccine, *obtained from the cultures of the commission*, are or are not inoffensive, and lastly, what is still more interesting, whether, from carefully collected statistics, the truth concerning their prophylactic action can be deduced. Does not your excellency believe this to be the matter of the greatest importance which my labors present?

"Besides, from the accompanying letter addressed to your excellency, it is evident that in the decree signed by your excellency the 17th of June, creating the commission, the latter had no other orders than to *go to Spain to study the attempts at choleraic vaccination made by Dr. Ferrán*, and I honestly believe that these attempts can be studied in a serious and useful manner with the knowledge of the nature of my cultures, the examination and verification of the results of which I refuse to no one in my own laboratory.

"This being the case, how is it that the worthy and illustrious commission does not begin its study and verification in the laboratory and in the infected villages, rather than in obstinately insisting on knowing of what consists my mode of attenuation of the cholera microbe. Is it insisted that this knowledge is at all necessary to determine the prophylactic action of the vaccine? Ah, Mr. Minister, we must then deny to all physicians the possibility of accepting the therapeutic efficacy of quinia, if they do not know how the bark from which it is produced is gathered and packed in the Andes.

"The doctors who compose this commission, appointed by your excellency, add, in opposing my position, that, being bearers of a letter from Mr. Pasteur, in which he cites the points on which they should particularly direct their labors, they thought that I would hasten to give him, whom I call 'master,' the means of judging of the value of my works, and they say such is not the case.

"Well, what says Mr. Pasteur, my venerated master, and the only person from whom I have received in all my troubles any moral support, and who, to begin with, is the only one who has the right to demand anything of me? Mr. Pasteur says:

"What is first desired to be known is whether you prevent the cholera in the inoculated persons. Aid our mission to arrive at a decision on this subject. You can do that by furnishing them the means of themselves making statistics. I entreat you particularly, besides the experiments relating to prevention that I speak of, to submit your cultures to the examination of these gentlemen, and, if possible, to send a few to my laboratory.

"The question of attenuated virus is yet so mysterious that no one is justified in throwing stones at you because of their preconceived ideas or *a priori* arguments. Facts alone must be invoked in order to pass judgment upon your method.'

"Your excellency sees that the eminent microbiologist, whom I venerate and respect, entreats me only to submit my cultures to the examination of the commission, and this I am not only disposed to do as many times as is desired, but I have already done it for these doctors in my laboratory. As to the facts, your excellency will comprehend, they are to be found by observation in the infected villages where the commission can determine practically whether my choleraic vaccine is or is not prophylactic. It is only after having examined and established its efficacy, now undoubted according to me, that the matter of knowing the process that I have discovered for weakening the cholera microbes should be agitated. *Is it pretended that I should make known the secret of the process of attenuation?* To do that I must find myself in very different circumstances from those which now surround me.

"Perhaps it will be objected that my attitude is not quite that followed by scientific men; but I would reply that, except in a few similar cases which might be met with, since everything in this world is dependent upon something else, so my silence is dependent upon the circumstances under which I am situated.

"After having devoted myself for a long time to microbiological studies, the municipality of Barcelona commissioned me to study the cholera at Marseilles and Toulon. As I became

acquainted with new forms of comma-bacilli of Koch, with their pathogenic and prophylactic action, I hastened to communicate this to the municipality that had honored me with its confidence and to the Government of my country. The latter, which ought to have been interested on account of humanity and national pride, replied by silent contempt. I have had no support from that side. The cholera having made its appearance in this Province (Valencia), I have been compelled to do everything myself, aided only by my indefatigable collaborator, Pauli, and by a professor of the faculty of medicine, Dr. Gimeno. I have inoculated several thousand persons without receiving at the beginning any pecuniary profit. After all this, and after my previous labors, in which I had sacrificed my tranquillity, health, practice, and the modest resources of an obscure village doctor, when, by the extreme importance of my discovery I was entitled to the assistance of my Government, I obtained from it only an unjustifiable prohibition to continue my inoculations (withdrawn after the report of the commission sent officially to investigate my work) and I became the brunt of attack of a hostile Minister of State, who has employed against me all sorts of arms—conduct all the more unjustifiable since long before this the Royal Academy of Medicine at Barcelona had published a favorable report of my work.

“I do not refuse absolutely and forever to abandon my reserve. If the Government of my country had been like that of Germany, which hastened to recognize in his obscurity and to splendidly recompense Robert Koch for the discovery of the spores of the bacillus of anthrax, or if it had imitated that of France, always ready to encourage that which is useful by extending a generous hand, my method should not be hidden from any one, and no one would complain of my reserve, for then I would have assurance of the legitimate enjoyment of my discovery; for it must be acknowledged, Mr. Minister, that all the glory in the world would not be sufficient, in case of my death, to free my children from the misery of poverty.

“In conclusion, Mr. Minister, I desire to make it clear that I do not oppose the examination of my culture liquids and of all the inoculation experiments and statistics that the honorable Commission appointed by your Excellency would like to make; that I believe I have correctly responded to the spirit and the letter of your decree of the 17th of last June, by which the Commission was instituted; and, lastly, that I am disposed to fulfill the requests and respond to the wishes that Dr. Pasteur specifically expresses in the letter invoked by Drs. Brouardel, Charrin, and Albarran.

“Deign to accept, Mr. Minister, the assurance of my most respectful sentiments.

“JAIME FERRÁN.”

We will not discuss at length this response; we will only remark that Mr. Ferrán persists in refusing to communicate to us the means by which he obtains the attenuation of the choleraic virus, that he equally refuses to allow us to examine the inoculation liquid outside of his laboratory. As to the motives invoked to justify his conduct, however softened their expression, they contain the kernel of those which he stated in our first interview.

We could not, under these conditions, form a definite judgment regarding the process extolled by Dr. Ferrán. Our official mission could not obtain the result desired. But we considered that it was our duty to gather all information possible in order to obtain an opinion on the probable value of the processes employed, as of the result of the choleraic inoculations.

We said therefore to Dr. Ferrán that, although our mission was terminated, we desired that he should show us, as colleagues simply, that which he desired to lay before us. He then conducted us into his laboratory.

We there met his collaborators, the principal of whom are Messrs. Pauli, Pasqual, a lawyer, an obstetrician, and a young doctor. Here is a list of the material found in his laboratory: Two microscopes, both void of special illumination; an objective No. 5 (old *Nachet*), which, combined with a No. 3 ocular, produces the greatest magnifying power that Dr. Ferrán can obtain; an incubator, composed of a rectangular wooden box, in the center of which burns a low gas jet; this incubator is without any regulator. Mr. Ferrán, in response to our questions, declared that he possessed no instrument capable of regulating the temperature. The



laboratory lacked all the usual coloring materials. Mr. Ferrán, who from a morphological point of view describes such extraordinary things, scorns the staining methods, the utility of which all microbiologists without exception employ. If we add to the above a certain number of gas jets, metallic screens, flasks, a few bottles of beef bouillon—certain samples of which appeared to us quite sterile—we will have given an exact idea of the scientific apparatus of the laboratory of the doctor of Tortosa.

Dr. Ferrán was desirous of showing us some preparations. The first, made by the means of a drop of water taken from a culture, contained a very limited number of spirilli of variable length the character of which it would be difficult to recognize on account of the imperfect means of examination. In the course and at the end of the spirilli existed a certain number of spherical bodies which Dr. Ferrán told us were magnificent examples of endogenous spores. One of the spirilli was uniformly beaded; Ferrán pretended that this appearance was due to the quantity of spores that it contained. In a second preparation we were able to recognize the existence of a certain number of mobile organisms, more or less resembling comma-bacilli.

The vaccinal liquid is yellowish, peculiar, very cloudy, and recalls the appearance of old cultures. Mr. Ferrán permitted us to examine a preparation obtained from the fluid that he told us was his vaccine. We saw in it numerous round bodies, some bacilli more or less resembling comma-bacilli, and little straight rods. Microbiologists are well acquainted with these rounded elements which are encountered at the extremities or in the course of certain bacilli. We asked Dr. Ferrán why he considered them spores; he replied, without furnishing a single preparation to justify it, that these bodies passed by successive development into the form of *muriform* bodies from which sprang a projection of protoplasm constituting spirilli. When the coiling of the spirilli is little marked their segmentation, according to Dr. Ferrán, gives birth to strait bacilli.

All these examinations were made with but a moderate illumination, an enlargement of from 700 to 800 diameters, whilst a magnification of from 1,000 to 1,400 diameters is that ordinarily employed to-day when it is desired to study the morphology of microbes (?). Besides, we repeat, all coloring was absolutely wanting.

As Dr. Ferrán could not show us the different phases of the morphology that he had described, phases which according to him everybody can easily reproduce, we entreated him to retrace theoretically the various evolutions of the comma-bacilli as he understood them. We recognized, from his own admissions, that he had modified his opinions and that he no longer attributed to the *öogonium*, the *oosphere*, and to the *polinide*, the rôle that he had assigned to them in his first memoir. He then revealed to us the state under which he believes the comma-bacilli present themselves in the water or the soil, but without ever having established it.

We also asked Dr. Ferrán why he could not permit us to see the special forms that he had described. He replied that he had preserved no preparations, that he possessed at that time no culture capable of demonstrating the morphological details, but that if we wished to wait five or six hours he could show us *muriform* bodies. Others, more fortunate than we, have been enabled to see these *muriform* bodies, which were interpreted by some Barcelona doctors the same as Dr. Ferrán, but were considered by Mr. Mendoza, of Madrid, as simple crystals.

In short, in regard to the morphology, we obtained nothing but partial promises; in short, all that which we were ourselves enabled to see was nothing new, and all that which in Dr. Ferrán's description was new, we were not able to see.

We then approached the experimental side of the question. As with the morphology, he told us that we had only to experiment ourselves. At the time we were in the laboratory, there were neither animals undergoing experiments, nor animals ready for experiments. To our remarks, Dr. Ferrán replied that, having finished the scientific portion of his labor, he busied himself only with the practical question, namely vaccination. Questioned regarding the symptoms that the animals presented after the hypodermic inoculations, he added that after inoculation of a minimum of two cubic centimeters, the guinea-pigs died in a few hours, presenting lowered temperature and shivering, without diarrhoea or vomiting,—no sign of cholera,

those above-mentioned being, as all experimentors know, common to many forms of septicæmia. In the blood of the guinea-pigs, according to Dr. Ferrán's statements, could be demonstrated a large number of round elements that he considered as micrococci; but there are seen neither spirilli nor comma-bacilli. If, however, one turns to the experiments of the Committee of the Academy of Barcelona, published in No. 6, volume VIII of the "*Gazette Medicale Catalane*," it is seen that the blood of the guinea-pigs is full of spirilli, commas, and several other hardly recognizable bodies. Moreover, Dr. Ferrán, according to his first communication, was formerly able to recognize muriform bodies in the blood of the guinea-pigs, an opinion already abandoned by him at the time of the report of the Academy of Barcelona.

In short, numerous variations in the opinions of Dr. Ferrán concerning results of experiments and morphology can be proven.

Passing on to the study of the vaccine, we again found that Dr. Ferrán refused to indicate his process of attenuation, that he also refused to allow us to take away any of the vaccine for the purpose of submitting it to our own tests, demanding that these tests take place in his laboratory.

To our great astonishment, he declined to reveal his motives for this action. However, Mr. Ferrán, who did not wish to give away the slightest amount of his vaccinal liquid, could, according to his admissions, manufacture two cubic meters of it per day.

On Wednesday, the 1st of July, he vaccinated in our presence twenty sisters of the Convent of the Little Sisters of the Poor. This is how he proceeded: He brought his vaccinal liquid in a special Ferrán flask, badly stoppered, allowing the contents during the journey to several times impregnate the cotton-wool and rubber which stopped the flask. Arrived at the hospital, Mr. Ferrán poured his vaccine into an unheated glass furnished by a sister. From that glass he rapidly filled a syringe with one cubic centimeter, having a single large needle, the ordinary capillary needles, according to him, breaking too easily. He injected this by pricking the upper back part of the arm, from above downward, neither taking the precaution of forcing out the air introduced in the syringe with the liquid, or of heating the point of the needle. Each person received a cubic centimeter of the fluid in each arm. Dr. Ferrán told us that in one minute he vaccinated four persons by eight injections. The persons inoculated thus, present in the following twenty-four or forty-eight hours phenomena of a peculiar uneasiness, stiffness, and lassitude, with thermic variations. There is neither vomiting nor diarrhœa. No more than with the animals is there a symptom resembling cholera. In the blood of the persons vaccinated, neither spirilli nor commas are discovered. In the dejections there are no comma-bacilli. In conclusion, we will say that the Madrid commission consider these inoculations as harmless. We have ourselves been able to realize that the persons inoculated presented the next day no grave symptoms.

Before proceeding to the examination of the results of statistics, we visited the cholera patients at the Convent of the Little Sisters of the Poor, where inoculations had been practiced the evening before, and to the temporary cholera hospital, where we were conducted by the mayor of Valencia and Dr. Gomez, professor of hygiene of the University of Valencia. We made an autopsy and determined that the causes of death were certainly those of cholera.

We asked Dr. Ferrán to tell us in what cities and villages he had practiced inoculations and which we should especially visit. At his direction, we went to Alcira, a town situated 37 kilometers southwest of Valencia; to Carcaganta, a town situated 7 kilometers southwest of Alcira; Alberique, 6 kilometers west of Alcira; and Algemesi, 5 kilometers north of Alcira.

The statistics obtained, such as are published, are not unfavorable to the practice of anti-choleraic vaccination. But before giving you the figures some remarks are necessary. The information that we are about to give was furnished us by the mayors of the towns and the governors of the provinces, who placed themselves at our disposition with a promptitude and kindness for which we are obliged, and for which we publicly thank them.

All informed us that as to authentic information regarding population no reliable statistics existed in Spain. Certain imposts resembling our octroi duties are subject to a very notable increase as the number of inhabitants increases. Therefore, the figures of the official census



are always below the reality. For example, for Alcira the official figures are 16,000, while the real figures are from 20,000 to 23,000; for Algimesi the official figures are 7,856, while the real figures are about 10,500.

These facts are confirmed by Dr. Gordillo Lozano, who in a pamphlet on the mortality of Madrid, appearing in 1885, says (page 170): "One of the principal reasons which cause the mortality of Madrid to be exaggerated, as compared with other capitals, is that the official census of the inhabitants is 200,000 less than the real census." Now the figures of the official census are not 400,000; there then is a mistake of one-third respecting the statistics of the Capital. It does not appear that the reported number of deaths due to cholera are more exact.

While going to Alcira we found ourselves in the same coach as the colonel of the 47th of the line (regiment of Tetuan) and two officers of his regiment. These gentlemen did not know who their companions were, or that one of them understood Spanish. The colonel is the commandant of the sanitary cordon which surrounds the province of Valencia. He stated in our presence to one of the officers that he had just imposed a fine of 125 francs on one of the mayors of the infected villages for the following reason: He suspected the declarations of this mayor regarding the subject of mortality under his administration; in the evening (in Spain interments take place at night during the epidemics) he posted two of his men near the cemetery with orders to count the number of the dead; the next morning they informed the colonel that there had been that night seven interments; the colonel went to the mayor, who declared there had been only two interments. Here the mistakes regarding the number of deaths was triple.

The same day we went to Carcagente. The mayor received us in the presence of some of the members of the municipality and two physicians, Drs. Martínez and Costá. To our questions he declared that although there were from 6 to 8 deaths from cholera per day at Carcagente, not more than three were reported, lest the village should be considered as infected, and consequently quarantined.

The difference is excessive, and no one can tell which deaths are reported, which are suppressed, and whether the errors favor the inoculated or the non-inoculated.

Before judging the value of the published statistics, we must recognize that we are ignorant of the true number of the population and of the deaths, and that the difference between official declarations and the fact is that a reliable deduction is impossible. These grounds of suspicion apply to all the death statistics of Spain, but there are two others which relate particularly to the statistics of Dr. Ferrán.

The first is this: The statistics of choleraic inoculations and re-inoculations are found exclusively in the hands of the partisans of Dr. Ferrán. I hasten to add that this is not his fault, for at one time the Spanish Government had forbidden his inoculations. They continued, however, more or less clandestinely, and the Government has given in and the practice has been resumed. At the same time, it seems that Dr. Ferrán for some reason does not desire to communicate his statistical collections to the governmental authorities, for the governor of the Province of Valencia told us in the presence of the mayor of that city, that the statistical representative of the Government having demanded the names of the persons inoculated they had been refused, but that he proposed to again demand them of Dr. Ferrán.

Finally, while Dr. Ferrán has assured us that at the beginning, the vaccinations were gratuitous, it should be stated that to-day a very large number (I can not say how many, not having the official figures) are paying. The prices vary from 5 francs to 12½ francs. Many of the believers in vaccination come to Valencia from the surrounding country; the vaccination house is always full and the personnel is organized so that the operations take place rapidly. Now, we know that it is particularly the poorer population that pays a large tribute to the cholera epidemics. Five or 10 francs, besides the expenses of travel, represents a very large sum. There is therefore, by the fact that vaccinations are paid for, a natural selection, which increases the number of persons vaccinated who are in easy circumstances and which gives deceptive statistics.

It is easy, after these remarks, to comprehend what the value of the published statistics is. We believe it to be our duty however to give the statistics which have been furnished us. Each one can judge for himself.

*Alcira*.—All information was furnished us by Dr. Estruch, one of the most ardent partisans of Dr. Ferrán. The detailed table that he promised us had not arrived at the time of our departure. We publish, therefore, the notes that he furnished us during our visit at Alcira.

The official population is 16,000, the probable, 23,000. Of the non-inoculated, minimum, 5,500; maximum, 12,500. Of the non-inoculated there were 430 attacked\* according to official numbers. The number of deaths reported was 169. There were 10,500 persons inoculated. Thirty-seven of these were attacked and 7 died. Of those re-inoculated 35 were attacked and 6 died.†

*Alberique*.—The population officially is 5,000; the minimum of the non-inoculated, 4,000. Of the non-inoculated, 192 were attacked‡ and 73 died. There were 938 inoculations; of this number 10 were attacked and 2 died. Of the number of re-inoculated which was large, 3 were attacked, now under treatment. This information was furnished officially by the mayor. They are taken from the death reports of the doctors. If the deceased had been inoculated the fact was recorded on the back of the report. The writing of this indorsement was not the same as that of the report, and no signature attached. The doctors of Alberique, we have been told, vouch for the veracity of the statistics published in the newspapers of Valencia.

*Algemesí*.—The official population was 7,856, the probable, 10,500. The official number of non-inoculated 6,600, the probable number, 9,300. Of this number 484 were attacked and 208 died. There were 1,200 inoculations; of this number 21 were attacked and 5 died. There were 632 reinoculations; 1 was attacked.

The mayor of Algemesi writes us that these statistics are in conformity with the reports furnished by the doctors of the town. One of the 5 persons who were vaccinated and died, was attacked only three days after vaccination. The mayor told us moreover that a family of 6 persons were all vaccinated except 1, and that one took the cholera and died; he could not enlighten us regarding the previous health of that person.

At *Carcagente*, they were not able to give the number of those attacked. They told us that out of 165 inoculated none were attacked. But a re-inoculated woman, who was a servant at the house of Mr. Pelayo in Alcira, died at Carcagente from a lightning attack of cholera. In a family of 5 persons, 3 had themselves vaccinated; the other 2 died of the cholera. These 2 persons were suffering from phthisis, and their state of health prevented them from being vaccinated.

The known statistics are not yet numerous, and it may be asked whether those unfavorable to the doctrine are published. Thus, the governor of Valencia informed us that at Masanasa 67 out of 100 vaccinated had been attacked by the cholera. These statistics would appear, they told us, in a Valencian newspaper of the 3d or 4th of July.

In reading these tables, that which strikes us the most is the number of re-inoculated attacked and dying. According to Dr. Ferrán's doctrine, those who are inoculated the first time possess only relative immunity; those re-inoculated possess almost absolute immunity. Now, in these statistical tables, we find 39 attacks among the re-inoculated and 7 deaths. The doctrine seems therefore fallacious; for the re-inoculated, the immunity appears to be only relative and not absolute.

To summarize: Scientific knowledge of the value of the methods employed by Dr. Ferrán to obtain the attenuation of the choleraic virus, and a satisfactory examination of the vaccine employed by him are rendered impossible by his refusal to reveal them. The opinions of Dr. Ferrán on the morphology of the bacillus and on the study of the blood of vaccinated animals have suffered numerous changes. The scientific apparatus of his laboratory is far from supplying the necessities to overcome the difficulties of bacteriological investigations. The vaccinal injections practiced upon men and animals develop no symptoms which suggest any form of attenuated cholera. It is true that the inoculations upon men appear harmless. But

\* The figures 430 should be reduced 56, that many being attacked before the inoculations began. The epidemic began in April, the first inoculations in May.

† One inoculated died at Carcagente.

‡ We do not know how many were attacked before the inoculations began.



the death statistics of Spain possess faults which render them absolutely worthless. The true number of the population is unknown; the number of deaths due to cholera is concealed. For particular reasons the statistics which the partisans of Dr. Ferrán publish are still more suspicious. Moreover, re-inoculation does not insure certain immunity against attacks. None of the arguments invoked in favor of this doctrine stand criticism; therefore, the proof of the prophylactic value of the anti-choleraic inoculations practiced by Dr. Ferrán is not established.

But it is not right that the error of one of the warm partisans of the germ theory should be reflected upon the doctrine itself. An imprudence is not enough to compromise its future. We are convinced that the discovery of the attenuation of a virus is and will remain one of the most brilliant examples of the progress of medical science to the end of the century; but in order to not encumber science by badly-formed conceptions, infatuation should be avoided even more than opposition.

When one encounters a person who wishes to pass from theory to practice and make prophylactic application of inoculations for human diseases, he must, before accepting these propositions, subject the method and procedure to the most rigorous tests. Jenner hesitated nine years before daring to inoculate James Phipps, the 14th of May, 1796. We have all been witnesses of the long hesitation and incessant labor of Dr. Pasteur before he dared affirm the value of attenuation of virus, and yet he had operated upon animals and had repeated his experiments constantly. To undertake such labors it is necessary that the complete and absolute honesty of the man be beyond discussion, for here honesty is more important than anywhere else. This consists in ignoring nothing that can compromise the life of his fellow man, in possessing a complete technical instruction, and in offering nothing without having first submitted it to every test. The nearer the problems relate to human life the more perfect the scientific method must be, the better must the savant be armed.

Dr. Ferrán seems not to have understood the importance of these truths, and he abandons the field of experiments and scientific studies too soon in order to enter upon that which he calls "the practical."

Accept, Mr. Minister, the assurance of our most respectful considerations.

BROUARDEL.

CHARRIN.

J. ALBARRAN.

PARIS, *July 5, 1885.*

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THE FRENCH AND BELGIAN COMMISSIONS CRITICISED BY FERRÁN.\*

Two French commissions came to Spain to study, upon the spot, our work of cholera vaccination. The first was M. Gibier, who received his commission from the Minister of Commerce; with him was associated M. Van Ermengem, sent by the Belgian Government for the same object, who is a micro-biologist with whom we have had scientific relations, and who has taken occasion to complain of the futility and barren results of his journey. Afterwards the same French minister thought that the matter possessed more importance than up to that time had been recognized in it, and, desiring at the same time to surround the matter with greater authority, appointed a second commission, composed of M. Brouardel, professor of medical jurisprudence of the faculty of Paris, M. Charrin, and Sr. Albarran, a young (South) American who had finished his studies at the said school of medicine, and who was a friend of and personally related to M. Brouardel.

For a rare exception, Frenchmen who for nearly a century have furnished us their ideas and their customs, their books and the results of their labors, came to Spain to study something which by its novelty had surprised them, and by its importance had attracted their attention. Such a thing was very unusual, and by reason of its infrequency, perhaps, the French commissioners came with a mind not altogether prepared to receive without prejudice the information which they sought.

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\* From *La Inoculación Preventiva contra El Cólera Morbo Asiático* por J. Ferrán. Valencia, 1886.

The results of the Brouardel mission have been much discussed during the past year in the national and foreign press, and in atheneums and academies; our conduct, and that of the French commissioners, has been so widely criticised with much heat and intemperance that perhaps, therefore, there has been nothing left to discuss, or perchance explain, although we find ourselves obliged to treat again of the same subject. There is little to add to that which at the time was said in defense of our attitude against the onslaughts and haughtiness of M. Brouardel and his associates of the commission.

The charge given by the Minister of Commerce to the said gentlemen was explicitly expressed by the decree, of June 17, in which he appointed them. In this it is declared that there is instituted "a scientific commission with the object of going to study in Spain the attempts at choleraic vaccination undertaken by Dr. Ferrán." Moreover, in a letter addressed to us by M. Pasteur, of which the same M. Brouardel was the bearer, the illustrious bacteriologist, besides other things, said: "What is necessary to know before all is, if cholera is prevented in the persons who are inoculated. Aid our distinguished commissioners to arrive at a just conclusion concerning this point. Do this by procuring them the means of forming their own statistics, present them with the proofs of the non-recurrence of the effects of your inoculations as well in man as in animals. At present so mysterious is the question of attenuated virus and of vaccination that no one is authorized to throw the first stone, justifying himself by preconceived notions and *à priori* reasoning. The facts alone should be relied upon for judgment of your method."

The precise and well determined charge of the French Government, the lucid suggestions of Mr. Pasteur, the constant practice in similar cases, and the courtesies of society required that Mr. Brouardel and his associates of the commission should have accommodated the course of their investigations to the desires of him whose procedure they came to examine, and should have caused them to follow the programme proposed by ourselves, more acquainted than they with the method which it was advisable to follow in order to make a fruitful study. It is at least the custom established and observed by men of science in their constant relations. But the French commissioners thought otherwise. Haughty and egotistical even from the commencement, they had very little faith in the truth of our method and of the results of the vaccination, or they came doubtless disbelieving that in a humble corner of a country thought little of by the foreigner because it is little known there could be found a remedy for a disease so terrible as cholera, to the study of which so many savans had already, without success, devoted their labor. It is certain that from the first Mr. Brouardel and his companions clothed all their actions with a marked air of superiority and with a mortifying suspiciousness more proper to masters who refused to believe in the merit of the pupil rather than play the part of companions animated with a noble desire of knowing that of which they were ignorant. Their questions in the form of exactions were so put as to inquire for the purpose of censuring more than for the purpose of learning. We expected to receive a scientific commission which had come to study the attempts at vaccination, and we met with a hostile jury which rather appeared to be interested in finding a cause or pretext for censure and attack than in manifesting a desire to encounter a truth which would excite applause.

Instead of submitting themselves reasonably to the programme of investigation presented by us the French commissioners had, the first day, the pretension to impose upon us their own, to lay down for us the direction of the experiments and to fix the manner and the order in which we must submit to their examination. Having been commissioned to *study* they began by presuming to *teach*; and as if these pretensions were not sufficiently irritating they brought the French consul in Valencia with them in order that, as Mr. Brouardel confessed in the Parisian press, he might serve as a witness for them in the interviews and might testify to our words. Such conduct could not be suffered without protest, and with those who in this manner thus forgot the consideration and the respect which men of science deserve among each other, we could not establish relations, at least in the official manner with which it was pretended that we should hold them.



The stiffness between them and us was from the first very visible and increased in proportion as their exactions were more disagreeable, for our self-respect was wounded; our refusals became more positive. The reports of some authorities, and especially of the civil governor of the province, Sr. Botella—to whose malevolence, plainly manifested toward us, was added the injustice and puerility of the municipal inspector of health, Don Constantino Gómez—contributed to the frigidness of our scientific relations and stimulated the hostility of the French commission. (See the report of Mr. Brouardel.) The governor, in abuse of his official position which caused him to appear more respectable in the eyes of the French commission than he really was, furnished them, as they themselves confessed, statistical data concerning the mortality in the villages inoculated, which, according to the documents that we publish in the appendix of this book, were in complete opposition to the truth. The inspector of health, by making use of the confidence which reports given by those who, like himself, filled an official position during the epidemic must, inspire, contributed in his turn to the constant persecutions of our work. With such assistance the mission intrusted by the French Government to Mr. Brouardel necessarily was without result. They constantly intimated to the latter and his companions that, far from being respectable and conscientious men who were laboring for the establishment of a useful discovery, we were scientific merchants practicing by credulity. Disbelief and suspicion were a barrier which very soon raised itself between them and us. They occupied themselves with extreme suspicion instead of observing, analyzing, and studying dispassionately; and we persisted in declining to be the pupils of those whom we could not in any manner consider as our masters. This is the explanation of the fiasco, with which, thanks to the unjustifiable superciliousness of the Frenchmen, their mission ended.

Their first exaction was that we should make known to them the discovery of what they called the *secret* of our virus. They made this a condition preliminary to entering upon the study of the results of the inoculation. In chapter 20 of our book\* we have explained very clearly that, far from being a secret, our virus could and ought to be known since the months of March and April (1885) by scientific men really careful to study all that related to our method. After reading the facts set forth in the said chapter it is difficult to understand how, four or five months after the report of the Royal Academy of Medicine of Barcelona, and the note presented to the Academy of Sciences at Paris, were published, the Frenchmen commissioned to study the choleraic vaccinations arrived without having previously endeavored to collect all the data possible concerning the subject which they came to examine. Does this not indicate a remarkable want of foresight and propriety in men truly scientific? Was it not ridiculous to come to Spain on the 30th of June in search of a *secret* which had been made public on the 15th of April in France?

Such demands surprised us and wounded our personal pride; but, determined to draw Mr. Brouardel and his companions from the error in which they found themselves, we wished, nevertheless—before arranging with them the manner “of furnishing them the means of forming their own statistics”—as the illustrious Mr. Pasteur suggested to us in his letter—to first make them understand that the secret which they sought had for some time been in their own house. Then the French commissioners especially showed their haughtiness. In no manner would they desist from their demand, as a condition necessary to the commencement of their investigations and their discovery of the *secret*. In vain we suggested to them the examination of our cultures, which a month and a half before the first commission appointed by the Spanish Government had examined microscopically. In vain, repeating the words of Mr. Pasteur, we told them that “only the facts should be relied upon for the judgment of our method;” that the epidemic unfortunately by its ravages furnished us material and opportunity to test the efficacy of the inoculation; urged that they themselves perform on a large scale vaccinations with cultures of the comma bacillus which they could examine and analyze at their pleasure; that this would furnish them with a broad and solid basis for an eloquent series of statistics, and that afterwards the hour would arrive and there would be time for giving themselves up fully to work in the laboratory. The programme of the French commissioners was rigid and inflexible, and they persisted in imposing it upon us, sacrificing to their obstinacy the mission with which the French minister of commerce had charged them.

\* Loc. cit.

Humiliated greatly by the disregard of the consideration due to a confrère of whom, instead of courteously requesting, the demand was made to give up "without reserve" the methods employed in obtaining the "attenuation of the virus," their obstinacy began by irritating us. From that moment our refusal to accede to the pretensions of the French commission were distinct and absolute. Perhaps we did wrong in leaving them to go on ignorantly believing in a secret which had no existence; perhaps we did not act properly in speaking of it to the minister; but then we thought that the ridicule under which the commissioners might have fallen when upon their return they found the explanation of our procedure, which the Academy of Sciences of Paris had published on the 15th of April, might be a chastisement of their tenacity and pride. If we were mistaken, it was not altogether our fault; and, moreover, our part in it was justified by the troubles with which we were surrounded on all sides by the excitement occasioned by the opposition that we met with, the persecutions of which we were the object, the daily labor and responsibility of vaccinating thousands of persons, and the pretensions of those who, forgetting the unusual circumstances, desired us to abandon all and devote ourselves tranquilly and patiently as in normal times to painstaking studies of morphology, and to the careful work of the laboratory, an account of which we had months before published in the national and foreign periodicals so extensively that only the careless or stupid were incapable of comprehending them.

If the French commissioners had had a real desire to know the truth they would have sacrificed to this desire every other sentiment; they would have endeavored to have lessened asperities by suavity instead of creating them; they would have accepted the programme presented by us; they would have convinced themselves of the irrationality of suspecting concealments and mysteries where there was nothing more than application of scientific principles known by every one, and they would have returned to their country with the satisfaction of having accomplished something for science and for humanity, and not with indignation at having been treated with injustice and pretentiousness.

(What these same gentlemen said in their report presented to the Minister of Commerce seems to be false, namely, that "with respect to the vaccinations there is no better proof than the result of the vaccination itself." If they thought this, why, instead of setting up their demands, which they made so obstinately, did they not endeavor to study on the ground of the epidemic itself the *results of the inoculation* in the thousands of persons who had submitted to it, and in the thousands who demanded to be subjected to it? The knowledge that the liquid which served for the inoculation was prepared by this or by that method would not have caused them to see better whether the vaccination prevented an attack of cholera or not; the latter was really what interested them, what Pasteur desired to be ascertained, and what the French Government had charged them to discover.)

On the 30th of June the French commissioners arrived at Valencia; on the 3d of July they left that city, and on the 5th of the same month they signed at Paris their report addressed it to the Minister of Commerce. A mission more rapidly accomplished, treating of a subject so important, can not be conceived. After the rupture of their relations with us, it would have been natural for them to have abstained from all investigations, since already the mission which had brought them in an official character to Spain had ended with our refusal. Under these circumstances they ought to have returned immediately to Paris and made known to the minister distinctly and laconically what had been the cause of their early return. Far from doing this, they thought, as they themselves say in their report, that it was their duty to collect the greatest amount of data possible, in order to form an opinion concerning the probable value of the procedures employed, and concerning the result of the anti-choleraic inoculations; and they devoted themselves to a collection of these data before proceeding to Paris, notwithstanding that they had already ascertained in their letter to the Minister of Commerce, dated at Valencia the 1st of July, that "they could not decide upon the value of the inoculations practiced by Dr. Ferrán without being acquainted in all their details with the procedures employed in making the culture and the attenuation of the virus." They decided at once *to form an opinion concerning the probable value of the procedures employed, and concerning the result of*



*the inoculations*, in spite of not knowing the manner of obtaining the virus; they themselves came to recognize the reason of our recommendation to them as a preferable method of study, that they begin at this *result* in the villages experiencing the epidemic before commencing their work in the laboratory. The strangest thing in this is that all the investigations made *en passant* by the French commissioners after our refusal were placed officially before the Minister of Commerce, through the medium of the report, as if they had not been officially brought to an end, since the commission should not have acted as still in existence after the moment in which it renounced its charge by breaking their scientific relations with us. And what investigations! And what a manner of collecting *the greatest possible number of data!* In the three days during which they visited our laboratory they could inform themselves of the class and number of persons who daily came to be vaccinated, and of the price and profit of our labor; they passed in review *our collaborators*, giving this title to all of those whom they saw associated with us a single time; they prosecuted the examination of our cultures, and by the use of the microscope saw in them spirilli and moving organisms which *resembled more or less the comma bacillus*; they made an inventory of our means of investigation which they found with us, poor and insufficient; they passed judgment upon the morphology described by us, the study of which had occupied two months at the Academy of Barcelona; they criticised our experiments upon the animals; they were present with us at the vaccination of the Little Sisters of the Poor; they inspected the provisional cholera hospital; they performed autopsies; they visited in a few hours various villages—the inoculated Alcira, Carcajente, Alberique, and Algemesí—in order to test the results of the inoculation; moreover, they found the census defective, the statistics and the statements of the physicians exaggerated or false; they were also able to collect upon their return, in a railway train, important revelations from the colonel of the 47th regiment (!) concerning the mortality of the cholera patients.

And this in three days! Really, the French commission could not be accused of slight diligence and little activity! But should they be censured harshly for their lightness, which was unbecoming of serious men, and for their statements and faithful reflex of their indignation? That report of observations made without official authority is no more than a tissue of passionate exaggerations, a fantastic relation of flying observations, of judgments precipitately formed, and of facts collected without order or arrangement, and without that serene and impartial tranquillity which passion does not disturb.

It was necessary, however, to justify the fiasco of the mission, which was due to haughtiness and stupidity, and they found no means of doing that better than violent attack and insult; and those gentlemen of such broad and solid understanding, pretending to judge of the merit of our work, performed their examination of the cholera vaccination in *three days* only by means of the reports of our enemies, and the data which the latter could, prompted by indignation and the desire for revenge rather than by the spirit of observation, furnish them.

Concerning MM. Gibier and Van Ermengem we have little to say. They came with almost the same disposition as did the Brouardel mission. They were, however, neither so haughty nor exacting. Upon leaving they left us a series of questions, all of which we answered, sending the reply to Paris, as we had agreed. Of the opinion of the said gentlemen we can affirm nothing, because up to the present they have not deigned to send us any periodicals or brochures in which they may have published it. Rumors have reached us of opinions annunciated by Van Ermengem contrary to our point of view and to the facts observed by us. If this be true we are sorry for the Belgian professor, because in that he will have given still another proof of his lightness and inconsequence.

[Under the next succeeding caption I reproduce a criticism of the Van Ermengem Commission by one of the colleagues of Dr. Ferrán. The remarks of this Spanish gentleman are introduced here in pursuance of my endeavor to lay both sides of this dispute before the American readers who may desire to have the information.—E. O. S.]

WRITTEN QUESTIONS PRESENTED ON THEIR DEPARTURE FROM SPAIN BY GIBIER AND VAN ERMENGEM, RESPECTIVELY FRENCH AND BELGIAN COMMISSIONERS TO INVESTIGATE THE FERRÁN INOCULATIONS AND WRITTEN REPLIES THERETO BY FERRÁN.\*

First question. *In what does your virus consist?*

Answer. This first question was answered some time since in one of the notes which I three months ago presented to the Academy of Sciences of Paris, bearing date 31st of March, which was read before that learned body on the 13th of April. In said note was explained the procedure which I follow in order to obtain the virulent culture of the comma bacillus for the purpose of using it as a vaccine; and at the end of the note I placed myself at the disposition of the illustrious academy in order to repeat my experiments before them. Up to this date I have received neither reply nor acknowledgment. Some time ago, therefore, an account of my procedure was in France.

Second question. *In what does the attenuation of your cultures consist?*

Answer. The culture of the comma bacillus which we use as a prophylactic fluid produces attenuated effects in connection with the cellular tissue into which it is introduced by means of hypodermic injections. That is to say, my choleraic vaccine possesses an analogy with that of charbon symptomatique, and that of *muermo*, whose pathogenic or prophylactic action depends, more than anything else, upon the part of the body into which it is introduced.

Moreover the cholericogenous microbe is attenuated in the culture media in proportion to the richness of the latter and in proportion to the chemical substances elaborated therein during the life of the same microbe.

Third question. *How do you know that your cultures are attenuated?*

Answer. The answer to this question is explained in the former replies.

Fourth question. *How long does the attenuation last?*

Answer. I have no data for the solution of that question.

Fifth question. *Can you produce different degrees of attenuation?*

Answer. Yes. And they depend upon the quantity of the culture fluid, upon the density or richness of the latter in microbes, and upon time.

Sixth question. *How do you produce experimental cholera in animals?*

Answer. I produce experimental cholera in guinea-pigs by the method which I described in the note presented to the Academy of Sciences of Paris above referred to.

Seventh question. *How do you know that it is cholera?*

Answer. As I do not inject into the guinea-pigs anything else than a pure culture of the comma bacilli—that is to say, of the cholericogenous microbe—all of the phenomena, including death, followed by the injections of the said culture should be interpreted as manifestations of cholera; at least this should be the interpretation of all bacteriologists who admit the comma bacillus as the specific cause of Asiatic cholera.

Besides, the symptoms observed in the guinea-pigs, the description of which I have published, conform with the pathological phenomena of the said disease in man. The differences which exist are explained by differences of organism. Two different (species of) animals respond in a different manner to the action of the same specific cause.

The virus of *muermo* does not produce in the dog anything more than an ulcer which soon heals; the anthrax virus does not kill fowls if their temperature is not artificially lowered.

Furthermore, in the specific diseases, opinions concerning etiology will be based upon the morbid characteristics, rather than resemblances of symptomology in different species of animals.

Eighth question. *Have you succeeded in producing an immunity of much duration in the animals?*

Answer. Yes. At least four months can be counted upon.

Ninth question. *What are the local and general symptoms which you observe in individuals inoculated?*

Answer. They are described in the said note presented to the Academy of Sciences of Paris.

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\* From actas de la discusion habida en El Ateneo acerca de la question Ferrán. Madrid, 1885.



Tenth question. *Have you examined the blood, the perspiration, the milk, the urine, and the dejecta of inoculated individuals?*

Answer. Yes. Neither the perspiration, nor the urine, nor the milk, nor the dejecta, contain comma bacilli; in the blood of the inoculated, a very few small granules are met with concerning the signification and cultivation of which I do not have sufficient data upon which to base conclusions.

Eleventh question. *Have you ever met with accidents as a result of the inoculations?*

Answer. Never when I have personally performed the injections. There are up to the present time more than 25,000 individuals inoculated in whom the number of hypodermic injections is more than 50,000; only a few phlegmons (none severe) have supervened when the operation has been performed by negligent assistants.

These phlegmons have not reached a dozen all told, and they have been produced, undoubtedly, because carelessness in sterilizing the syringe has allowed the culture of the comma bacilli to become contaminated by pyogenous germs.

Twelfth question. *Are the accidents which you point out to be interpreted as unfavorable to the method?*

Answer. No. By comparing the 50,000 hypodermic injections of cultures of the comma bacillus, with as many others performed with any medicament whatever, including pure water, the truth of my negation will be obvious.

General accidents my inoculations have never produced; all the general phenomena observed have been those which I assign to the physiological action of the vaccine fluid, and are those to which I refer in my reply to the ninth question.

#### REPORT CONCERNING AN INVESTIGATION OF THE FERRÁN VACCINATIONS.

By GIBIER AND VAN ERMENGEM, 1885.

Drs. Paull Gibier and Van Ermengem (Compt. rend. des scien. T. CL. No. 7, 17th August 1885), presented a note of their experimental researches of cholera before the French Academy of Sciences; they constituted a commission sent to Spain for the purpose of examining and reporting upon the anti-choleraic inoculations of Ferrán. The note is couched in the following language:

Sent to Spain by our respective Governments (Van Ermengem by Belgium, Gibier by France), to study the method of anti-choleraic vaccination of Dr. Ferrán, and to report upon this question we desire to state that we have arrived at conclusions practically identical.

In order to discuss this method in a scientific manner, we would remark, that it is necessary to wait before forming a definite judgment until we may possess arguments based upon facts, that is, upon the results of experiments made upon animals. Upon our return from Spain we set to work; to-day we are in a fair way to prove that the subcutaneous injection of cultures of the comma bacilli do not protect the animals experimented upon. The following is in effect what we have learned:

A series of guinea-pigs received subcutaneously two cubic centimeters of virulent cultures of the comma bacilli upon the 12th and 13th of July last. Three weeks after this inoculation, the effects resulting therefrom having completely disappeared, we injected into these same animals a quantity of culture fluid, sometimes into the stomach, and by way of the mouth, according to the method of Koch, sometimes into the duodenum, after incision of the abdominal walls; these animals died with clinical and anatomical symptoms of cholera. Microscopic examination by plate cultures, revealed an enormous quantity of comma bacilli in the intestinal contents.

In communicating this short note we intend to take account only of facts; we shall not, therefore, follow Dr. Ferrán in the numerous contradictions found in his different communications. We should remark that our inoculations have been made with non-attenuated cultures, obtained from the laboratory of Ferrán; notwithstanding this, of twenty animals inoculated under the skin, four only died as a result of the injection; the others, during three or

four days, showed considerable disturbances which gradually and finally disappeared. These febrile disturbances were due certainly to the presence of living formed elements, which, until they disappeared, acted upon the tissues; for no effect was observed after inoculation of three or four times the quantity of the same fluid in which the bacilli had been killed, by subjecting them for 24 hours to a temperature of 65 degrees C.

We have not observed those gangrenes, nor those lardaceous abscesses which Ferrán described.

Neither in the blood, nor in the intestines of the guinea-pigs which succumbed to the subcutaneous injection, was any trace of the bacillus of cholera to be found. On the other hand, at the point of inoculation, large numbers of them could be seen at the end of three days. Death in these cases appeared to be due to the intensity of local disturbances.

It should be observed that the dose of 3 cubic centimeters of hypodermic injection in a guinea-pig corresponds according to the weight of the animal, to a quantity which would be slightly less than half a liter of virulent fluid for a man of medium weight. Notwithstanding this, the immunity conferred by this inoculation is nil, for the pig is an animal which takes cholera with difficulty; is not then the conclusion justifiable that with man it ought to be the same?

#### REPORT UPON THE ANTI-CHOLERAIC VACCINATION OF FERRÁN.

GÆTANO RUMMO, of Italy.\*

Doctor Rummo ends his report to the Italian Minister of Public Instruction concerning the Ferrán inoculations with the following conclusions:

(1) Ferrán does not use all the indispensable precautions while practicing the hypodermic inoculations.

(2) The local and general effects of the inoculation (pain, redness, œdema, fever) do not correspond to the symptomology of cholera, but, on the contrary, present the picture of a slight septicæmia, similar to a certain traumatic form of the latter affection.

(3) *The blood of the inoculated does not contain comma bacilli.*

(4) The vaccination in man does not protect from cholera.

The statistics furnished by Ferrán and his assistants show absence of real control, which, however, the official commission has been able to rectify.

(5) The vaccine of Ferrán is not, indeed, a culture fluid of *unvariable constitution*; at times it is an impure culture of comma bacilli, and at times a fluid containing numbers of micro-organisms, among which the comma bacillus exists in small numbers or is entirely absent.

(6) In either case the subcutaneous injection of this vaccine material does not protect against the ingestion into the stomach of pure cultures of comma bacilli, made after known methods. Its protective power is therefore nil.

(7) These diverse vaccines injected under the skin of the guinea-pig even to the amount of several cubic centimeters produced no genuine choleriform symptom. According to their composition and the amount injected they cause at one time phlegmons and eschars and at another time they remain inoffensive.

The divers micro-organisms of this vaccine, isolated and injected, possess different morphological qualities and pathological properties; in quite considerable doses some of them cause death.

(8) Altogether the Ferrán vaccine can not be regarded as a simple impure culture of the comma bacillus. The comma bacilli of the vaccine bouillon do not behave like the ordinary comma bacilli in peptone gelatine.

(Hypothetically it may be said either that the multiplication of other micro-organisms hinders their development, or that the vaccine bouillon is subjected to a special unknown treatment.)

\* Relazione sulla vaccinazione anti-colerica del dott. Ferrán.—Giorn. internaz. d. sci. med. Napoli. 1885. fasc. 9-10.



Two reasons speak in favor of the latter supposition : (a) The guinea-pig which ingests ten cubic centimeters of the vaccine bouillon becomes sick, but recovers, whilst of the other animals which take this dose of the pure culture of the comma bacilli all succumb ; (b) The slow development in the peptone gelatine, the "meschina" form of the comma bacilli contained in the vaccine bouillon, and the absence of forms of rapid development, such as the spirilli.

In the present state of science and popular experience concerning vaccination an anti-choleraic vaccination is not impossible, and there is no reason to regard the matter as unfounded. The method of Ferrán, therefore, is faulty, not in principle but in application and in the precipitancy with which he has announced as demonstrated that which was not so.

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THE FIRST COMMISSION APPOINTED BY THE SPANISH GOVERNMENT.\*

A few days after the commencement of the prophylactic inoculations in Alcira (May, 1885) the Minister of the Interior, Sr. Romero Robledo, to whom we had telegraphed five months before from Tortosa, giving him an account of our discovery of vaccination against cholera, without his having taken the trouble to reply to us, found it necessary to appoint a commission to proceed to the province of Valencia in order to report upon the nature of the reigning epidemic † and upon the truth concerning our labors. He had been impelled to this by public opinion, influenced by the news daily published in the press, and in particular by a most eloquent discourse pronounced in the chamber of deputies by Sr. Emilio Castelar, and another pronounced in the senate also by the learned professor of the faculty of medicine of Madrid, and senator for the University of Barcelona, Sr. Juan Magaz.

The commission appointed by the minister was composed by Don Francisco Alonso Rubio, president of the royal council of health, professor of medicine, and a physician who had been a member of the royal house of deputies, a person prudent, discreet, of correct judgment, and vast information; of Don Aureliano Maestre, of San Juan, professor of the faculty of medicine of Madrid, and a distinguished histologist; of Don Alejandro San Martín, also a professor of the same faculty, and one of the most distinguished members of the profession in Spain; and of Don Antonio Mendoza, director of the bacteriological laboratory, which the provincial legislature of Madrid instituted in San Juan de Dios. To this commission was added Don Eduardo García Sola, professor of medicine in Granada, who had been commissioned on account of his experience in micro-biology by the legislature of that province. Later the commission was joined also by the chief military physician, Don Anacleto Cabezas, sent by the minister of war, and Don Vicente Cabello, of the superior council of health of the navy by the minister of that department, but both of them without voice or vote—the first a studious micro-biologist and the second an acknowledged hygienist. (Later in Valencia the president of the Academy of Medicine of that city, Sr. Elías Martínez, was added to the commission.)

Don Francisco Alonso was president of the commission, and Don F. Castellote acted as secretary, a man nothing but a politician, enjoying the whole confidence of the minister.

The hostility of the minister to our work made itself manifest from the very first: it was either because the discourse of Castelar wounded his *amour propre* by criticising his official inactivity; or because we had publicly expressed ourselves against the system of quarantine and of the ridiculous sanitary cordons, which were his only measures and hope against cholera; or because he was influenced by the official leaders of science in Madrid, envious that anything should have been done in a corner of Spain of which they had not dreamed; or because badly informed by the civil governor of Valencia, our declared enemy on account of matters which we will relate in another place.

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\* From Ferrán's *La Inoculación*, Loc lit.

† The disease was Asiatic cholera, declared so without equivocation or circumlocution by the board of health of Játiva in the month of March. The governor of Valencia, Sr. Botella, knew it perfectly well, as did also the ministers, as was natural, for whom it was not convenient to make it public on account of political reasons. For this reason he denied in parliament that cholera existed and ordered us to vaccinate at Calcutta!

The commission reached Valencia, where they encountered in the highest civil authority a constant obstacle of the worst kind. Every difficulty was raised on the part of the governor against the work of investigation. Many days were lost in the capital by the fault of the latter, who received from the minister orders and instructions which both pretended the commissioners themselves had suggested, but which emanated solely from the secretary, who alone represented the hostile spirit of Sr. Romero Robledo, being the soul of all those dark intrigues with which at the very beginning he undertook to play upon men of science. It was sufficient for the commission to speak of an infected town to have the governor, under the pretext that the epidemic was committing ravages in it, order immediately a cordon. Museros is an example of this, where the epidemic caused numerous victims, and whose vicar came with tears in his eyes to beg the president, Don Francisco Alonso, that he would bring us and the commission immediately to inoculate the inhabitants. Sr. Alonso Rubio, moved by these prayers, promised the vicar to do so on the following day, but on the following day we did not go because Sr. Botella ordered a rigid cordon around the village. On the other hand, we had been on the foregoing day at Puig, and when we arrived there in the afternoon train neither the mayor, nor the secretary, nor the physician, nor the inhabitants knew one word of our visit and of our intention, and yet the night before the governor had promised to announce our journey; the telegram of advice arrived an hour after we found ourselves in the village, making asses of ourselves and shamefully humiliating the commission.

Finally the commissioners received in a few days orders to proceed themselves to Játiva, where there were scarcely any cases of cholera. Sr. Garcia Sola, perhaps already wearied with such treatment of a scientific commission by people who ought in every way to have facilitated their work, went to Madrid without learning scarcely anything. Telegram after telegram from the minister arrived at Játiva; an early report was urged. They complained in Madrid that the commission with its investigations was spending too much in feasting. Orders came exaggerating the urgency, and Commissioners Alonso Mæstre and San Martine, who were the sole ones left in Játiva, finally departed for the capital. (Sr. Mendoza remained in Valencia in order to study the morphology of the microbe, according to himself, in order that he might discover the vacciniferous position of the comma bacillus, as El Mercantil ingeniously said.)

According to the foregoing it was impossible that the commission in three weeks could arrive at a solution of the difficult problem which they were directed to study.

It is not strange then that they did not do more. In its endeavors it displayed earnest desires and noble intentions; if anything were lacking it was the energy sufficient to protest against the secretary, the governor, and the minister, and stand up for the respectability of men of science and for the independence of the commission.

Nevertheless the commission arrived at conclusions which read as follows:

CONCLUSIONS OF THE FIRST OFFICIAL COMMISSION APPOINTED TO STUDY THE PROPHYLAXIS OF ASIATIC CHOLERA BY THE METHOD OF DR. FERRÁN.

- (1) The disease prevailing in the villages of the province of Valencia is Asiatic cholera in disseminated foci.
- (2) The present epidemic is more contagious than infectious, because in almost all the villages there is a belief that it has been imported by persons proceeding from infected points.
- (3) The fluid prepared by means of the cultures of Dr. Ferrán contains comma bacilli, as shown by the microscope.
- (4) The inoculation is harmless as far as public health is concerned, since the effects, local as well as general, produced by the inoculation are slight, and commonly disappear in forty-eight hours.
- (5) The statistics collected up to the present by the inoculators appear to favor the procedure; but they are as yet few, and are not official, as they should be for the formation of a definite judgment concerning the preventive value of the inoculations.



(6) The commission is of the opinion that the experiments by Dr. Ferrán should be continued, but watched by a representative of the Government, in order to prevent abuses and to collect regular statistics.

(7) The inoculations should be allowed to be made by no one else than Dr. Ferrán, or under his direction, and should be gratuitous for the poor.

The commission understands that these are the only means of bringing to a definite solution the difficult problem which they have been charged to solve.

Finally, the commission can not do less than respectfully represent to the Government of His Majesty that Dr. Ferrán is a man of science, probity, and good faith; that he may be mistaken, but his good intentions can not be doubted; that he has undertaken the study of this question with a constancy and zeal so admirable, that they entitle him to the protection of the Government and the gratitude of humanity.

MADRID, *June 23, 1885.*

FRANCISCO ALONSO, *the President.*

F. CASTELLOTE, *the Secretary.*

AURELIANO MAESTRE DE SAN JUAN.

EDUARDO GARCIA DE SOLA.

With the reservations set forth in the adjoining special report.

ALEJANDRO SAN MARTIN.

#### CONCLUSIONS OF THE SPECIAL REPORT SUBSCRIBED BY DR. ALEJANDRO SAN MARTIN.

(1) The suspected disease raging in Valencia should be now regarded as disseminated Asiatic cholera. This last qualification and those which, according to a certain epidemiological doctrine, follow with it, explain that the epidemic in Valencia is less infectious than former epidemics; but it should not on that account be called contagious in the strict epidemiological meaning of that word.

(2) The later statistics of the anti-choleraic inoculation do not appear to promise results so exact and satisfying as might have been furnished by a minute scientific examination scarcely yet commenced of the physiological, pathological, therapeutic, and prophylactic action of the said method.

(3) Dr. Jaime Ferrán deserves, on account of his scientific attainments, to be fully re-instated in his professional rights, and placed at entire liberty to pursue his labors in accordance with law.

Such is the especial report, adhering to the letter of the directions prescribed in the royal order of the 28th of last May, which is forwarded to your excellency by that member of the scientific commission appointed by the said royal order, who, with proper respect, subscribes himself,

MADRID, *June 25, 1885.*

ALEJANDRO SAN MARTIN.

The report of the commission was signed by all of the members except Sr. Mendoza, who was in Valencia, occupied, as we believe, with studies of transcendental morphology which have absolutely nothing to do with the vaccination of cholera, and with which, moreover, time was lost at the expense of acquiring knowledge concerning prophylaxis during the days when the epidemic was already making serious ravages in various provinces. The said report of the commission was altogether as favorable as it could be concerning the circumstances under which they had to perform their labors. The question at issue was not solved, because the commissioners could not solve it with the facts obtained; but it was declared that our virus consisted of a culture of the comma bacilli, thus announcing officially what some months before the whole world could have known, if they would have taken the trouble to read; that the inoculation was harmless; that the statistics appeared favorable; that experimentation should continue; and that Dr. Ferrán was entitled to the protection of the Government—a protection which the Government did not accord in any manner.

The special report of Dr. San Martin did not differ from the former, as has been seen, ex-

cept in certain considerations respecting the etiology and pathology of cholera, and the method which ought to be followed in investigating the inoculations.

The remaining member of the commission, Sr. Mendoza, who, as we have already said, had remained in Valencia, presented his own report a month afterwards; that is, on the 22d of July. The paragraphs of this report relate to two subjects: First, to the morphology of the microbe of cholera; and second, to the study of its pathogenic and prophylactic action on animals. We publish sections of it below:

THE SPECIAL REPORT OF SR. ANTONIO MENDOZA.

(1) That from the micro-biological experiments performed in Játiva (9th of April), as also from the observations of the commission (28th of May), and from the autopsies performed afterwards, it is conclusively proven that the epidemic which commenced in the province of Valencia is Asiatic cholera.

(2) That the details of the evolution described by Dr. Ferrán in the supposed peronospora Farrani has phases of the comma bacillus which do not correspond in any manner to the classic description of the evolution of the peronosporaceæ.

The so called oogonia, in our opinion, are nothing else than deformities produced by age and debility of the spirilli.

The muriform bodies are crystalloid globules, produced by the crystallization of the elements contained and formed in the fluid culture with the interposition of colloid material; for this reason there is no real reproduction of clouds of protoplasm. Spores do not exist in the comma bacillus, as the experiments of many of the most accomplished observers prove. It follows that the microbe of cholera has no other method of reproduction than fission without the generation of a resistant form (spore), and that by its botanical characters it belongs to the group of spiro-bacteria; and by reason of this, and by its consistent existence in the patients attacked by cholera, it deserves the name of *spirillum cholerae*.

(3) That from all of our experiments in attempting to produce cholera by hypodermic injections, as well as from those performed by Nicati, Van Ermengem, and Doyen, who obtained similar negative results, it follows that the cholera microbe, although introduced by this method at its maximum activity, into the organism of the animals, does not produce pathological phenomena, much less experimental cholera.

(4) That the foundation of the preventive inoculations is the claim that by inoculating into animals (guinea-pigs) an attenuated culture, the latter can subsequently receive with impunity another inoculation of maximum virulence. This claim is in open opposition to the results obtained by experienced experimenters and to my own careful and methodically directed investigations, and it necessarily follows that the preventive action of the culture of Sr. Ferrán has no solid or real scientific base, and that therefore the claim is false.

These are, your excellency, the conclusions which are to be drawn from my investigations, and which I have the honor to submit for the judgment of your excellency.

Nothing, as I say, scientifically supports the preventive method of Sr. Ferrán, and therefore I affirm that the explanation given by the said gentleman is incomplete, and in absolute discord with the results obtained by various experimenters and with my own, and I am unable to approve in any manner those upon which the said Sr. Ferrán bases his vaccination.

It is lamentable that a good intention should not have been followed by better results.

May Heaven preserve your excellency many years.

MADRID, 22d July, 1885.

Your excellency,

ANTONIO MENDOZA.

To His Excellency THE MINISTER OF THE INTERIOR.

All of these conclusions, says Dr. Ferrán, have been already answered in this book\* in the chapter headed "The Comma bacillus, Its Culture and Morphology."

Nevertheless, we ought to reply that Sr. Mendoza is one of those who have seen our

\*Loc. Cit.



so-called oogonia; those who have been unable to see it, for example Sr. Garcia Sola, one of the members of the commission as sent by the provincial legislature of Granada, who also published another report, whose conclusions we insert further on, from which it follows either that Sr. Mendoza was more fortunate than Sr. Garcia Sola in the examination of his cultures or that the latter gentleman was more careless in his investigations.

The great care which Sr. Mendoza gives to the examination of the morphology described by us should be noted; half of his conclusions refer to this, according to him, important subject, which we repeat has nothing to do with the anti-choleraic vaccinations; and all this useless labor which occupied him up to the middle of July, as he said with the intention of testing a part of what he had done some months before, but interpreted in a special manner, in conformity, however, with other foreign micro-biologists. He did one thing original: the naming of the cholera microbe "spirondulophito."

With respect to the interesting question of the power of vaccination, he limited himself to saying that there was nothing which would scientifically explain its truth, because various foreign experimenters, and he himself, had not succeeded in killing guinea-pigs with hyperdermic injections of the comma-bacillus. Whilst Sr. Mendoza lost time in experimenting with animals, the epidemic caused numberless victims, and thousands underwent inoculation without him taking the trouble of examining for himself the effects of cultures of the microbe in numerous individuals of the human species who demanded inoculation, and of personally collecting truthful statistics. His negative results in the guinea-pigs could be of no use to him, although the experience was arrived at in a better way than were the positive results in man.

The report of this commission, together with the special report of Sr. San Martin, unaccompanied as we believe by that of Sr. Mendoza, because it arrived too late, was sent to the Royal Academy of Medicine of Madrid, which learned body concluded thereon as follows:

#### CONCLUSIONS OF THE REPORT DRAFTED BY THE ROYAL ACADEMY OF MEDICINE JULY 21, 1885.

(1) The suspicious disease prevailing in Valencia should be regarded now as disseminated Asiatic cholera. This last qualification and those which, according to certain epidemiological doctrine, follow with it, explain that the epidemic of Valencia is less infectious than on other occasions, but it should not be called contagious in the strict epidemiological meaning of that word.

This conclusion admitted, the same proviso was made in the second by vote of the majority.

(2) The latest statistics obtainable of the anti-choleraic inoculation do not appear to promise results so exact or satisfactory as a careful and scientific study would have afforded concerning the physiological, pathological, therapeutic, and prophylactic action of the said procedure—a scientific study which at present has scarcely begun.

The academy do not doubt that the theoretical study of the knowledge upon which the prophylactic inoculations are founded is of great interest, but this does not invalidate clinical experience which is the ultimatum that sanctions or denies support to medical theories.

(3) Dr. Ferrán deserves, by his scientific attainments, to be early and fully reinstated in his professional rights, being left at complete liberty to prosecute his labors under the law.

The academy insists upon the deliberations had concerning the four last conclusions voted by the majority.

The report of the commission ends with a petition to the Government of His Majesty affirming that Dr. Ferrán is a man of science, probity, and good faith; that he may be mistaken, but his good intentions can not be questioned; that he has studied this question with a constancy and a zeal so admirable that they entitle him to be accorded the protection of the Government and the gratitude of humanity.

The academy hold, however, that the Government is not obliged to protect or recommend the procedure of Sr. Ferrán whilst it does not rest upon solid scientific foundations, and whilst, besides, the beneficial results which are attributed to it are not established before recognized authorities in science.

(It is strange that the academy confound here the protection of the Government to Ferrán,

which the report of the commission advises with protection to the procedure. They are two things entirely distinct.)

Such is the report which the academy present for the consideration of your excellency in order that you may take it for what you believe it to be worth.

May heaven preserve your excellency many years.

Madrid, July 21, 1885.

Your excellency,

THOMAS SANTERO,  
*The President.*

To his excellency the MINISTER OF THE INTERIOR.

This report is accompanied by a special report, whose conclusions we also publish.

#### CONCLUSIONS OF THE REPORT OF THE MINORITY.

They (the choleraic inoculations) ought not to be authorized:

(1) Because, aside from the disturbances already mentioned, the inoculable fluids may, according to the modern doctrine of cholera, which we neither affirm nor deny, be the producing and propagating cause of the disease, for it is not understood that the rigor of the sanitary laws for the isolation and disinfection of persons and effects proceeding from infected points is applied in this case, but that on the contrary, the elaboration and transportation without any hindrance of the supposed elements of cholera is permitted.

(2) Because, approved hygienic measures and scientific means of avoiding and ameliorating the ravages of the epidemic in the faith which this means inspires or may inspire, like everything which offers a protection against human troubles, and especially that which is aided by certain prestige and some mystery.

And finally, the authorization of the inoculations would be the establishment of a precedent very unfortunate for science and for society, since the sanctioning of experimentation upon man without conscientious and repeated tests would be to expose humanity to become the victim of any audacious experimenter whatever, who, emboldened by the example, would undertake to perform similar experiments with agents scarcely less dangerous than choleraic inoculation.

(Every day physicians perform experiments of this kind, and to no one has it as yet occurred that on this account professional liberty must be limited in the least.)

Besides, Dr. Ferrán should and may be able to demonstrate the truth of his assertion before men of science as Pasteur did, and as Koch and others have believed they had done for a discovery useful to science and humanity. This up to the present moment he has not done in any authenticated manner, nor has he done so before the commission appointed for that purpose.

The signers of the report do not believe that the denial of the authority to make the inoculations constitutes an attack upon personal freedom, because the rights and the liberty of the individual in the social sphere and of science meet limitations, for when bad use of these prerogatives may cause a prejudice to the public health, the law restricting them and the penal code should be and are indispensable moderators.

For all the reasons set forth the academicians who subscribe, agreeing in general to the scientific points of the report with the majority of the academy, believe it their duty to inform the Government that while accepting conclusions first, second, third, and fifth of the said report, are prompted to disagree with the fourth and sixth, formulating in their stead the following:

(4) The facts adduced are not sufficiently conclusive to affirm, without reserve of any kind, that the inoculations are harmless for the individual and for the public health. Because, of the absence of ascertained data respecting the impossibility of producing and propagating cholera either by the inoculations or by the liquids which are used for the inoculations, as well



as because of the facility with which the liquids become altered and because of special conditions of receptivity in the persons inoculated, the undersigned believe it their duty not to declare the inoculations harmless.

(6) That for the above reasons the practice of inoculation ought not to be permitted until Dr. Ferrán, by experiments and proofs which scientific representatives exact of him, proves the scientific bases of his system, the truth of his affirmations, the entire harmlessness of every inoculated case, and the impossibility that the procedure can favor the propagation of cholera in villages not invaded.

(7) And in case that the inoculations should be permitted in order to prove upon man the beneficial results which are attributed to them, they should be performed in limited districts by Dr. Ferrán himself, or under his immediate direction, and subjected to the supervision of a representative of the Government, who, with Dr. Ferrán, should collect the statistics, taking into account the age, sex, constitution, profession, and social condition of the inoculated, as well as the local conditions and the extent of the epidemic as compared with the former ones. The inoculations should be voluntary and gratuitous until their real utility be established, the Government being charged with the expenses incurred by Dr. Ferrán for the time occupied by his experiments, and guarantying to him the right of invention and a recompense worthy of the discovery, if experiments shall prove completely its efficacy.

Such is, your excellency, the opinion which the academicians, who subscribe, have the honor to submit for your distinguished judgment.

Madrid, July 22, 1885.

JAVIER SANTERO,  
JOSÉ DIAZ BENITO,  
JOSÉ BENA VIDES.

To his excellency the MINISTER OF THE INTERIOR.

The majority of the academy are not willing that this special report should remain without answer and vote the following:

#### CONCLUSIONS RESPECTING THE OBSERVATIONS ADVANCED IN THE SPECIAL REPORT.

The committee of the academy would point out:

(1) That those conditions would have to be fulfilled probably after the cholera epidemic shall have disappeared, and with it the best opportunity of making use of the value of the inoculation, if indeed there should be any.

(2) That precisely the first condition which should be exacted is that of practical results, satisfactory and well established; and these would be hardly obtained by preventing the inoculations.

(3) That it is not lawful to deprive a physician of the use of a means which he considers advantageous for his patients, and which he puts in practice under his legal responsibility, while it is not clearly seen that it is prejudicial to public health.

(4) That the government and the public are equally interested in the solution of this question, and its solution as much as possible in the light of day; that the question far from being cleared up would be obscured by the prohibition of the public use and by the clandestine practice which would probably be the consequence of prohibition.

All these considerations have been taken into consideration by the committee, causing it to believe that for the present there is no reason for opposing obstacles to a procedure which can not be characterized as anti-scientific, in whose support facts more or less established are adduced—a procedure which is within the rights of the physician and which is demanded with earnestness by a multitude of persons who see in it a means of salvation in the unhappy circumstances which surround them.

Would that it were possible that, in view of the value of experimentation, it might be convenient for the Government to intervene more directly in order to regulate and conduct it with greater rapidity to a conclusion; but meanwhile the government can at least abstain from committing blunders which besides being unjustifiable might be reactive.

With these reflections the committee has offered all which it desired to say respecting the special report.

MADRID, *July 20, 1885.*

MATIAS NIETO SERRANO,  
*The President.*

The report of the majority of the academy is not as explicit as that of the commission, but it also is favorable and much more if the spirit of resistance which all scientific bodies whatever they may be opposed to innovations is taken into account. This is already so traditional that every one admits it as a rule, although there are a few rare, honorable exceptions.

The special report of the minority is distinguished by its exaggerations. It decided upon placing obstacles of every kind in the way of the practice of inoculation, and in alarming public opinion and furnishing a pretext to the minister to prohibit the inoculations. The most surprising thing of all is that of the persons who signed this report at least one, its author, Sr. Santero, did not believe that the comma bacillus is the cause of cholera, as he publicly said at that time in the discussion which took place in the Ateneo—an obvious proof that he sought to occasion alarm by a phantasm which he was the first to laugh at.

The minister, in spite of his hostility and his manifest aversion for us, freely authorized the inoculations after these reports.

The gentlemen commissioned by the minister of war presented a report highly favorable, the conclusions thereto subjoined are as follows :

CONCLUSIONS OF THE REPORT OF THE CHIEF PHYSICIAN OF THE ARMY OF THE PHILIPPINES,  
DON ANACLETO CABEZAS, APPOINTED BY THE MINISTER OF WAR.

- (1) The suspicious disease prevailing in Valencia is Asiatic cholera.
- (2) In the vaccination fluids of Dr. Ferrán the presence of the comma bacillus is always demonstrated.
- (3) The inoculations performed with it are harmless, and their prophylactic power appears to be proven.

Don Vicente Cabello, of the superior sanitary council of the navy, who was appointed by the minister of the navy, also announced an opinion equally favorable to our method of inoculation.

In consequence of the reports of Drs. Cabello and Cabezas the ministers of the navy and of war authorized the vaccination in the army and in the fleet.

At the same time and even before his excellency the minister of the interior appointed the commission of whose report we have previously spoken various bodies (provincial legislatures and municipalities) determined to send also their commissioners to study in Valencia the disease prevailing there and the anti-cholera vaccination.

Not all of the reports presented by these commissions, although official, have reached our hands, but we can affirm that very few of them have failed to reach us. Only those of Saragossa and Alicante, whose opinion was among the most favorable to our procedure, as shown by the reception given us in the month of August by the physicians of Alicante (Dr. Escolana, Dagnino, etc., the first sent by the legislature), and the discourses pronounced in their turn at Saragossa by Srs. Gimeno, Aralendia and Vega, professors of that faculty of medicine and commissioned by the municipality and the Academy of Medicine of that city.

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THE SECOND COMMISSION APPOINTED BY THE SPANISH GOVERNMENT. \*

In view of the opposition which the practice of inoculation experienced, in spite of the favorable results furnished by the villages, after the minister of the interior limited singly to Ferrán the authority to vaccinate, the governor of Valencia ordered an administrative dele-

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\* Ferrán, loc. cit.



gate, not a physician, in order to witness from all points of view the act of inoculation and watch the exercise of our profession, we decided to suspend our labors, and Ferrán went to Madrid, resolved to defend before the high powers of the state his right and the dignity of his profession.

A few days later Don Raimundo Fernandez Villaverde occupied the ministry of the interior. To him we applied, and also to the then president of the council of ministers, Don Antonio Canovas del Castillo, who at first appeared to be not at all or but little disposed in our favor, but later, appreciating the great interest of the subject for the public health and for the national honor, was inclined to furnish us the means of obtaining an official statement of the truth.

(The subject of the preventive inoculation against cholera had assumed from the beginning a markedly political character, which we did not contribute in any manner to lend it. It was enough for the minister, Señor Romero Robledo, to declare himself the adversary of the inoculations for his political enemies to become our partisans, this division of sentiment creating difficulties for us rather than favoring our labors.)

Another commission was appointed for the purpose of accompanying us to the villages that demanded to be vaccinated and of watching the practice of inoculation in order to testify officially if it had or had not a prophylactic value. Three individuals, appointed by the minister, Señor Villaverde, constituted this commission. Two of them (his particular friends and associates) were Señors Florencio de Castro (charged with the work of dissection in the faculty of medicine of Madrid, possessing some skill in the preparation of anatomical specimens, but in no way recognized as a bacteriologist) Manuel Sanz Bombin, chief of the section of hygiene of the province of Madrid—it is understood that the physicians constituting the department of hygiene under the provincial governments of Spain are charged with watching the health of the women inscribed in the official register as prostitutes), and Mario Gongalez de Segovia, physician to the Maternity Hospital. The commission was therefore composed of an anatomical prosecutor, of a syphilographer, and of a gynecologist, all of them somewhat expert in the subject of their studies, but entirely without authority for the examination of bacteriological questions. Nevertheless, if this subject might be resolved simply on the ground of practice or empiricism, these three physicians, with a proper disposition, might be sufficient, but it was not desired to limit the matter simply to that. This badly chosen expedition did not resolve, as it should have done, the interesting point of the prophylaxis of cholera\*

To the medical commission another was united, a statistical, composed of the chief of the statistical bureau of the province of Saragossa, Señor Ranz, and four assistants. For the first time the Government directly collected statistics of the inoculations.

To speak of the opposition of every sort, of the incessant irritations and humiliations which the second medical commission occasioned us, would be to lose time or at least to go too far, especially as we intend to make known later on everything which contributed to make our labors completely sterile of result in spite of the fact that the statistics continued to show us to be right.

It is sufficient to read the conclusion of the report presented by Señors Castro, Sanz Bombin, and G. Segovia to comprehend, especially if they be compared with those of the first distinguished commission, the mean and narrow, hostile and malevolent animus of these gentlemen. So exaggerated are the said conclusions that the desired effect of discrediting the procedure of inoculation was not produced, and our most intelligent adversaries had to look with distrust upon a document which instead of a report is an attack. The conclusions of this report are as follows:

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\*One of the members of the said commission, Dr. Sanz Bombin, had arisen to pronounce a discourse against choleric vaccination in the Society of Hygiene of Madrid, where the matter was then being discussed. This alone ought to have been sufficient to have prevented him from accepting a charge which would oblige him to report upon a subject of which he had already previously formed an unfavorable opinion. This fact and other curious details concerning the second commission we have noted in a book *Historia de la vacunacion colerica en espana*.

CONCLUSION OF THE REPORT PRESENTED BY THE SECOND OFFICIAL SCIENTIFIC COMMISSION  
APPOINTED TO ATTEND AND WITNESS THE PRACTICE OF THE PROPHYLACTIC METHOD OF  
DR. FERRÁN:

(1) The prophylactic inoculation against Asiatic cholera, according to the method of Dr. Ferrán, can not be considered as harmless for the individual because of the general and local effects which it produces in the majority of the inoculated.

The inoculations were practiced in the presence of the official commission at three points: Ondara and Santa Pola, in the province of Alicante; and Cambrils, in the province of Tarragona. In none of these points, of many thousands of the inoculated, were there any important accidents; not a single one of them died from the results of the inoculation. The general and local effects were the same as those already described in this book, only in Cambrils eight phlegmons were met with, of which we have spoken in one of the previous chapters. Upon what data do the members of the commission base the statement that the procedure "can not" be considered as inoffensive? Were they appointed to report upon a "can not," or to address themselves solely to the result furnished by the statistics? But since this result could not be more eloquently in favor of the harmlessness of the vaccination, they had to resort to theoretical disquisitions in order to justify their opinion upon this point with a hypothetical or a problematical "can not." Not wishing to be more explicit, it would have been logical and discreet for them to say: Since by the observation of thousands of the inoculated in different points and under various conditions, it seems that the inoculation has not caused death or grave accident to any of them, it would appear that up to the present there is no reason to consider this procedure dangerous.

That the facts upon which we plant ourselves are exact, the statistics collected by the Bureau charged with this work, under the presidency of Señor Sanz, testify. In Ondara not one of the inoculated died, there were no phlegmons or local accidents of importance; neither did the appearance of cholera follow the inoculation. In Santa Pola only one patient inoculated died of cholera within the five days following the inoculation; neither did any accident of importance occur there. (See the statistics which we publish at the end.) In Cambrils there were only eight phlegmons certified by the physician whose certificate we have published in another chapter. Furthermore, in none of the three villages did any person inoculated die of any other disease whatever.

Does any one suppose that the one death from cholera in Santa Pola, and the four in Cambrils within the first five days after inoculation, were occasioned by the inoculation? If it was believed that they died of cholera in consequence of injecting the comma bacillus into the cellular tissue, why did the same commission in the fifth conclusion say that the symptoms which were observed in the inoculated were not the symptoms of experimental cholera? Does one desire to see a more perfect contradiction? Because, if the comma bacillus introduced hypodermically can not produce experimental cholera, how could it kill the inoculated with cholera?

We hold then: First, that the five deaths among the inoculated were from cholera and, according to what the commission say in the fifth conclusion, they could not have acquired it by inoculation. Second, that since the five died within the five days above mentioned, and considering the period of incubation of cholera, it may have been possible that they were vaccinated whilst the germ of the disease was latent within them. If, possibly, the commissioners could not admit this manner of looking at the question they could have said so in Madrid before their departure, and not have accepted the commission, because every one knew the statements of our vaccination cards (they were published in the "Gazeta de Madrid" when the first official commission was appointed in May. Third, that there were no accidents of any importance other than the eight phlegmons of Cambrils, a result which if it be imputed to the choleraic inoculation can with more reason be attributed to hypodermic injection of any medicine whatever, and the physician would create a bad impression concerning his knowledge and his skill who would pretend to deny it. Fourth, that none of the inoculated died of any other disease.



Upon what then does the commission base itself when it says that the inoculation *can not* be considered as harmless? Does not the vaccination against small-pox cause much greater disturbance? Has it ever occurred to any one to say that cow-pox can not be considered as harmless?

The second conclusion is worded thus:

“(2) There does not exist any proof showing that the liquid intended for inoculation is an attenuated culture of the comma bacillus.”

We do not understand what the commissioners desire to say by this; perhaps the report which has not yet reached the public may explain. After six months from the publication of the manner of obtaining our virus, the members of the commission do not yet know whether the microbes of our cultures are attenuated or not; but as they have had no reason to interest themselves with such a thing, how could they have proof that the bacilli of the virus were not attenuated? By the microscopic examination? We do not admit such a heresy, for every one knows that it is not by the morphological characters, etc., that the greater or lesser virulence of a microbe is recognized. By the experimental study of the action of the liquid in animals? We do not know with what culture they may have made that, for we do not believe that they pretend to have followed this method with the two or three centimeters of the virus which they one day begged of us, the sole time that they made any use of our cultures and the only time that they manifested any desire to have them. Do they, perhaps, calculate that the microbe was not attenuated because of its action upon the inoculated man? Neither do we admit that, since they are the first to deny that the symptoms of the inoculated are those of experimental cholera. We are reduced then to this, that the members of the commission *supposed* that the microbes of the vaccination liquid were not attenuated by any procedure known to bacteriologists.

“(3) There is no fixed criterion in the practice of the inoculations, either as to the choice of the liquids which are employed, or as to the establishment of the relation which should exist between the quantity and the quality on the one hand, and the individual conditions of the inoculated on the other—the only constant rule being the greatest variation in the richness of the culture employed.”

Since the report of the commission has not been published, as we have already said, we do not know in what manner its members measured the richness of the cultures; but we suppose that it would not be by the microscopic examination of a fraction of a drop much less by looking into the flasks. We repeat, that only on one occasion did they take any of the virus, whether for the purpose of examining it, or for another object we do not know; but if they had taken it for the purpose of ascertaining its richness in germs, they did not have the possibility of comparing it with that of other cultures, because they had not studied them. Or is it that they supposed, perhaps, that placing the eye to the eye-piece of a microscope would be sufficient for the calculation of the abundance or the scarcity of the comma bacilli in a culture?

(We believe, judging from what happened in Cambrils, that this was their sole manner of examining that point. The president of the commission, Señor Castro, approached the microscope which we had placed upon the table for the examination of a drop of the virus, and was very much chagrined because, upon going to move the focus by means of the coarse adjustment instead of by the micrometer, we advised him of his mistake and that he was likely to break the preparation, and very much vexed he turned to the secretary, Señor Gonzales Segovia, and said: “I am satisfied; look yourself, Señor Segovia, this culture is less rich in germs than that of yesterday.” This scene took place before various persons, among them several physicians of Reus and Villaseca, who will testify as to its exactness).

“(4) If the foundation of the method of Dr. Ferrán, based upon the doctrine which admits the comma bacillus as the active cause of Asiatic cholera, is accepted, it must follow that the individual inoculated can transmit the disease to the rest of the population by frequently carrying the said micro-organism in his clothes, thanks to the defects of the method of inoculation.”

For what purpose did the members of the commission have by their side a statistical commission if not to base their report upon the results of the statistics? In Ondara there were

1,205 persons inoculated ; many more remained without inoculation, and yet the cholera was not transmitted from the former to the latter. Is this mode of arriving at conclusions by the Commission serious ? Their duty was not to base themselves upon reasoning concerning doctrines more or less acceptable and accepted, but upon facts perfectly established by themselves ; and, although reasoning might lead them *à priori* according to their understanding to say that the inoculated could transmit the disease, the facts of Ondara required them to admit that *more than a thousand inoculated were unable* to transmit cholera to the many others not inoculated.

For speculations about a possibility it was unnecessary for them to have moved from Madrid ; from that point they might have felt disposed to say that those inoculated with the comma bacillus could transmit the disease just as well if they had not left for a moment the discussion in the Society of Hygiene. The question which they had been charged by the government with solving was certainly not the ascertainment of the possibility or the impossibility of this or of other matters, but that of positively affirming or denying the deductions from our doctrine and our facts.

“(5) The *ensemble* of symptoms which the inoculated present does not warrant considering them as characteristics of experimental cholera.”

In the corresponding chapters of this book we have already said what is necessary to combat the basis of such negations.

“(6) The person inoculated is in the first days succeeding the inoculation more apt to contract every kind of disease, because the inoculation destroys more or less profoundly the physiological equilibrium so necessary during epidemic periods.”

This conclusion is obviously absurd and scarcely deserves answer. By this manner of reasoning we would have to admit also that the persons inoculated against small-pox, by the fact of experiencing local symptoms and fever, are more apt in times of epidemics to suffer from all kinds of disease ; are the members of the commission of those antiquated physicians who believe that during an epidemic of variola it is unadvisable to vaccinate ?

As is seen in this and in other conclusions the commissioners have manifested a tendency to discuss every subject and cover all ground, whether absurd or not, against the vaccination of cholera, forgetting to remember that what proves everything proves nothing.

The conclusion of the report is as follows :

“(7) From an examination of the effects of the re-inoculations and of the experiments performed by the commission it is not proven that the method of inoculation by Ferrán produces immunity against cholera, nor is it possible to draw any conclusion of this kind from the statistics obtained, in view of the fact that from isolated cases general laws can not be deduced.

“May heaven preserve your excellency many years.

“MANUEL SANZ BOMBÍN.

“FLORENCIO DE CASTRO Y LATORRE.

“MARIO G. SEGOVIA.

“MADRID October 3, 1885.”

The members of the commission assert that it is not possible to say anything positive concerning the existence of an anti-choleraic immunity produced by our inoculations in view of the fact that the statistics collected refer to *isolated facts*, which can not serve for the deduction of *general laws*. Notwithstanding this, they have stated *general laws* based upon these same *isolated facts* : First, that the individual inoculated is more predisposed, during the first days, to contract all kinds of diseases ; second, that cholera can be transmitted by the inoculation alone ; and third, that the inoculation is not harmless.

These conclusions constitute a model which we would not recommend to any one who desires to follow the methods of logic and good sense.

Their assertion that prophylaxis by vaccination has not been established we will answer with the conclusions of the statistical commission which accompanied them, and which exclusively limited itself to facts and figures :



CONCLUSIONS OF THE REPORT SUBSCRIBED BY THE CHIEF OF THE STATISTICAL BUREAU OF  
THE SECOND SCIENTIFIC COMMISSION.

From what has been already stated, and from the figures of the statistical tables, the following conclusions result:

- (1) The vaccination did not produce cholera in Ondara.
- (2) In Santa Pola only one person inoculated was attacked with cholera. The attack occurred within the fifth day, and death followed after it. One of the inoculated was also attacked by other diseases.
- (3) In Cambrils the four inoculated who died with cholera were attacked within the fifth day.
- (4) In the same town, counting from the day when the inoculations began, the per centage of attacks among the inoculated, within the fifth day, and the non-inoculated is less than the proportion of the inoculated inhabitants to the non-inoculated; but, counting from the fifth day after the commencement of inoculation, in this case the relation of attacks in the inoculated to those in the non-inoculated is greater than that of the inhabitants inoculated to those non-inoculated by 4 per cent.
- (5) In Ondara the relation of attacks as well as deaths from other diseases between the inoculated and those not inoculated is less than that of the inoculated inhabitants to the non-inoculated.
- (6) In Cambrils no inoculated person died from other diseases.
- (7) In the said town the relation of attacks from other diseases among the inoculated to those among the non-inoculated is greater than that of the inoculated inhabitants to the non-inoculated.

The conclusions 1st, 2d, 3d, 4th (1st hypothesis), 5th, and 6th are entirely favorable to the prophylactic procedure of Dr. Ferrán. It would be desirable that such conclusions were corroborated by larger figures in order to raise them to the level of demonstrated laws.

JUAN SANZ,

*Chief of the Statistical Section of the Commission,*

*Third Official of the Bureau of Statistics.*

MADRID, December 5, 1885.

Excepting a few reflections which are based upon the relative paucity of data, the conclusions of the statistical commission, signed by its president, Sr. Sanz, are entirely satisfactory.

How is it, then, that the medical commission has been so much in discord with the statistical, both having for their judgment the same facts?

The report of the commissioner, appointed by the Spanish minister of war, concerning the anticholeraic inoculations is favorable to the Ferrán methods, and ends with the following conclusions:

CONCLUSIONS OF THE REPORT OF THE SURGEON-GENERAL OF THE PHILIPPINE ARMY, DON  
ANACLETO CABEZAS.

- (1) The suspicious disease prevailing in the Province of Valencia is Asiatic cholera.
- (2) In the vaccine fluid of Dr. Ferrán the presence of the comma bacillus is always to be demonstrated.
- (3) The inoculations performed with this vaccine fluid are inoffensive and their prophylactic power appears to be a reality.

Don Vincente Cabello, member of the supreme council of health of the navy, who was appointed by the minister of marine to investigate the Ferrán question, also published an opinion equally favorable to the Ferrán inoculations.

## DR. FERRÁN AND THE SCIENTIFIC QUESTION OF CHOLERA VACCINATIONS.

By Dr. ABREU, of Portugal.\*

This author, after a somewhat prolonged visit to the field of operations of Dr. Ferrán for the purpose of individually studying this question, returned to Portugal and prepared a long report, the conclusions of which are here appended:

## FIRST SERIES OF CONCLUSIONS.

- (1) The Ferrán question is not solved.
- (2) The Ferrán question has a scientific basis which theory accepts and which practice does not reject.
- (3) The biological study of contagious germs does not constitute a commercial enterprise; the application of these studies to the individual and public prophylaxis of specific diseases is not a simple question of dollars and cents.
- (4) Jaime Ferrán y Clua is a physician and not a charlatan; is a bacteriologist and not an ignoramus; he is a clinician in the serious practice of his profession and not a mere prescriber of drugs.
- (5) The medical doctrine of choleraic vaccination, even when considered as a simple humanitarian and scientific undertaking, inaugurated in Spain by an obscure physician, deserves the respect, examination, and attention of all physicians, schools, and scientific institutions.
- (6) All medical associations should examine with the greatest circumspection, intelligent foresight, activity, zeal, and loyal assistance every attempt which has for its object the removal from Europe of a calamity which by the panic which accompanies it discredits science, relaxes the administration of the government, places villages in antagonism with each other, impoverishes and saps the sources of national wealth.
- (7) The movement occasioned by the discovery of Dr. Ferrán, in which many governments of Europe, learned institutions, and official commissions composed of eminent physicians were associated, was not a masquerade, but has as its basis one of the most legitimate and imperative modern necessities which science and civilization alike are interested in.
- (8) All the foreign commissions which were at Valencia returned much impressed by the practical results obtained by the anti-choleraic vaccination.
- (9) None of these commissions remained long enough to acquire decisive and reliable proof against the procedure of Ferrán.
- (10) Not one of these commissions affirms and proves in a definite manner that the scientific problem of choleraic vaccination is or is not solved.
- (11) Not one of these commissions demonstrates that human vaccination of the choleraic germ is a scientific error, an absurd conception, and a dangerous experiment.
- (12) In all the official reports of the official commissions there exists official doubts. Therefore, when doubts concerning a subject exist, it is imprudent to speak of it as solved.
- (13) After these reports were presented, it seemed to their authors that there was nothing more to do than to add to their final conclusions against Ferrán the statement that some of the commissioners, as Gibier and Van Ermengem, would conduct new investigations in order to arrive at new conclusions; which proves the precipitation with which, during a stay of forty-eight hours at Valencia, they desired to pass judgment upon the matter; and which demonstrates that they were under the necessity of continuing their studies. At one time they make subcutaneous injections into guinea-pigs in order to study the effects of preventive inoculation! At another time they talk also of the statistics, opposing to the thirty thousand human inoculations performed by Ferrán the inoculations which they have succeeded in performing on twenty guinea-pigs! (See the report presented to the Minister of Commerce of the French Republic, read before the Academy of Medicine at the session the 21st of July, 1885.

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\* Abstract from Ferrán's *La Inoculacion Preventiva*. Loc. cit.



Bulletin de l'Académie de médecine, Nos. 28 and 29; also the notes of Dr. Van Ermengem presented to the editor of the *Deutsch. med. Wochenschr.*, which appears in No. 33 of the *Medicina Contemporanea*; and the communication made to the Academy of Medicine of Paris, 18th of August, 1885, by Drs. Gibier and Van Ermengem, *Bulletin de l'Académie de médecine*, No. 33.)

(14) All that the political, commercial or news periodicals of Portugal, Spain, France, Italy, etc., have published against or in favor of the doctrine of choleraic vaccination, aside from the consideration which the writers deserve, explains nothing, proves nothing, and resolves nothing.

(15) Neither have the articles, pamphlets, communications, telegrams, notices, and protests published by periodicals exclusively medical, condemning Ferrán and rejecting his scientific attempts, aside from the consideration due their authors, succeeded in casting the least discredit upon the experimental question of human vaccinations; and with respect to such opinions unless they can cause more serious studies of this subject they can accomplish nothing in favor of or against the conquests of biology.

(16) Some of the official commissioners in Valencia have fallen into lamentable contradictions: Thus Dr. Van Ermengem, in his remarkable book published two months before his mission to Valencia, tells us: “(a) That the discoveries of Dr. Ferrán are of extreme importance; (b) that the facts enunciated by Dr. Ferrán, very extraordinary as they appear, ought not to be despised without previous examination; (c) that Dr. Van Ermengem subjected these facts to an experimental investigation; (d) that he proved the exactness of some of the affirmations of Dr. Ferrán; (e) that in the cultures and microscopic preparations he met with certain forms of development pointed out by Dr. Ferrán; (f) that although it is possible to differ from the Spanish physician as to many points of his technique, according to the belief of Dr. Van Ermengem, the existence in the cycle of development of the comma bacillus of forms which have not been pointed out by Koch, and which afterwards have been seen by many observers can not be doubted; (g) that in the cultures from the dejecta of Dr. Ferrán, who was infected accidentally after his own vaccination, Dr. Van Ermengem met with numerous choleraic organisms.” Finally, referring to the discovery of the virus announced by Dr. Ferrán, the Belgian microscopist exclaims that: “With respect to the discovery of protective vaccination against Asiatic cholera which may appear to some to be too beautiful to be true, it may some day be established with all the experimental exactness necessary, and be an eternal honor to the microbiologist who first pointed out its possibility! (*Recherches sur le microbe du cholera asiatica. Rapport présenté à Monsieur le Ministre de l'Intérieur, le 3 nov. 1884, par le Dr. Van Ermengem, Bruxelles, 1885, pp. 334, 335, 346, and 347.*)

Two months afterwards in Valencia the same microscopist, complaining of the secret of Ferrán, with less acrimony than that of the Brouardel Commission, and more scientifically than the commission of Gibier, asserted that the cultures are old and that the forms in the cycle of development of the comma bacillus are unusual! (*Loc. cit.*, p. 244.)

(17) It has happened also that this matter has been combatted by individuals who, having committed the inconsistency of denying that the condition produced was cholera, and having pronounced in their writings against the labors of Ferrán, when it is necessary to test the latter, find themselves under the unfortunate necessity of sustaining or justifying their position, even when their consciences condemn them.

In order to excuse their false step, they endeavor in the meanwhile to copy with alacrity from the periodicals all that may serve them against the seriousness of the human vaccinations and to launch against Ferrán in default of better arguments the same epithets which their predecessors had employed against Jenner.

(18) The Royal Academy of Medicine of Madrid departed notably from the report presented to it by the official commission of the Spanish Government. That report contained different statements, because the members of the commission dissented in opinion concerning cholera and the medical doctrine of choleraic vaccination. It is certain, however, that in a report signed by all the members of the official commission the following paragraph is met with: “The commission can not do less than address a respectful prayer to the Government of his

majesty representing that Dr. Ferrán is a man of science, probity, and good faith; that he may be mistaken, but his good intentions can not be doubted; that he has brought to the study of this question a constancy and zeal so admirable that they entitle him to the protection of the Government and to the gratitude of humanity."

And in the special report given by one of the members of the commission, an eminent professor of medicine, it is affirmed that Dr. Ferrán is a man strictly scientific, and that his investigations constitute just ground for the praise of his country. In the said report exists the following conclusion: "Dr. Jaime Ferrán, on account of his scientific acquirements, deserves to be fully reinstated in his professional rights, and left at entire liberty to pursue his labors subject to the regulations of the law."

(19) The official report of the Portuguese commission is the most complete of all as to the general study of the subject. It considers the doctrine of cholera vaccination, and is not unfavorable to Dr. Ferrán; but, notwithstanding the high scientific value of that doctrine, it did not affirm many points as established, and it did not declare officially whether the choleraic vaccinations were or were not efficacious.\*

(20) The scientific academies of Lisbon, Turin, Munich, Bonn, Berlin, Vienna, Budapesth, Brussels, Copenhagen, Stockholm, Liège, St. Petersburg, Boulogne, Amsterdam, Dublin, Rio Janeiro, New York, and Washington have also considered this question.

(21) The Societies of Medical Sciences of Lisbon, Porto, Göttingen, Kaiserslautern, Washington, Bordeaux, Toulouse, London, Haarlem, Pisa, Moscow, and Geneva did not solve this question.

(22) The institutes of Coimbra, Milan, Naples, Venice, London, France, and Essex are silent.

(23) The faculties of medicine of Coimbra, Madrid, Paris, Montpellier, Dublin, Oxford, Leyden, and Rome examined the subject in order afterwards to decide in favor of or against the medical doctrine of choleraic vaccination.

(24) The Academy of Sciences and the Academy of Medicine of Paris did not approve the conclusions of the official reports which were presented. Pasteur insists that further experimental investigations should be made, because they were confronted with a scientific problem of extraordinary scope and with a physician of incontestible practical resources and intelligence.

(25) At the last scientific congress convened under the presidency of the learned Verneuil, professor of the Faculty of Medicine of Paris, was read a most important communication by Chauveau, a member of the Academy, broadly discussing the Ferrán question, and, as if no official or officious reports contrary to the procedure of the Spanish physician existed, Chauveau demonstrated the scientific basis of choleraic vaccination, and among other conclusions affirmed: "(a) That the attempt of Ferrán to obtain artificial immunity against cholera is legitimate; (b) that science authorizes the attempts at preventive inoculation against cholera by the injection of fluid cultures of the comma bacillus into the subcutaneous connective tissue; (c) that there is reason for following with interest the inoculations performed by Dr. Ferrán." †

\* Report of the Portuguese Commission, composed of the professor of the faculty of medicine of the University of Coimbra, Drs. Lorenzo de Almeida y Azevedo, Filomena de Camera, Mello Cabral, and Dr. José de Azevedo Maia, professor of the School of Medicine and Surgery of Porto, presented on the 7th of July to his excellency the minister and secretary of commerce, Augusto Cesar Barjona de Freitas (*Diario do Governo*); and "The Cholera in Valencia and the Prophylactic System of Dr. Jaime Ferrán y Clua," by Philomeno de Camera de Mello Cabral, professor of general histology and physiology in the faculty of medicine in Coimbra, commissioned by the Portuguese Government to study the epidemic and the prophylactic system, Lisbon, 1885.

† *Gazette hebdomadaire de médecine et de chirurgie*, 21 août 1885: The communication of Chauveau was so eloquent and learned that this French periodical, so reserved and incredulous concerning the Ferrán question, commented upon it in the following terms: "M. Chauveau arose to discuss the theoretic value and the consequences from the practical point of view of experiment of the inoculation of Dr. Ferrán; it is fortunate to see so intricate and obscure a subject studied, analyzed, and exposed by a man possessing such ability, and whose opinions are authoritative in such matters; if he was unable to entirely solve the problem he at least sharply defined its limits, and caused the probable solution of the question to be foreseen."



## SECOND SERIES OF CONCLUSIONS.

- (1) The liquid used by Dr. Ferrán for cholera vaccination exercises an obvious pathogenic action in the human species.
- (2) In some cases this pathogenic action determines the benign symptoms of an attack of Asiatic cholera.
- (3) The cholera vaccination does not expose the individual to severe accidents.
- (4) The vaccination and re-vaccination confer immunity.
- (5) The choleraic vaccination discovered and practiced by the Spaniard, Dr. Jaime Ferrán y Clua, constitutes one of the most notable scientific experiments of the present century.

## SECTION 3.

## REPORTS OF COMMISSIONS OF SPANISH PROVINCES AND MUNICIPALITIES.

*REPORTS OF VARIOUS OFFICIAL COMMISSIONS SENT BY PROVINCIAL LEGISLATURES AND MUNICIPALITIES.\**

At the same time, and even before his excellency the minister of the interior appointed the commission of whose report we have spoken in a previous chapter, various popular bodies (provincial legislatures and municipalities) decided to also send commissions to investigate the disease then reigning in Valencia and the cholera inoculations.

All of the reports presented by these commissions, although they are official, have not reached our hands ; but we give the assurance that those that are wanting are very few. Indeed, only those of Saragossa and Alicante, whose opinion was most favorable to our procedure, as is proved by the reception which we received in the month of August at the hands of the physicians of Alicante (Doctors Escolano, Dagnino, etc.), and by the discourse pronounced upon their return to Saragossa by Señors D. J. Gimeno, Aramendia, and Vega, the professors of that faculty of medicine. All the other reports we possess, and we copy their conclusions, as follows :

## CONCLUSIONS OF THE COMMISSION FROM GRANADA.

[Delegated by the provincial legislature of Granada and associated with the first official commission of the Government: Doctor D. Eduardo Garcia-Sola.]

- (1) I was not able to confirm the morphological evolution of the oogonium, oosphera and muriform bodies described by Dr. Ferrán of the comma bacillus.
- (2) The prophylactic fluid employed for the inoculation contained commas, and the technique of the inoculation is very simple.
- (3) The effects of the inoculation present no similarity with the clinical symptoms of cholera, the symptoms of diarrhoea being almost always wanting. I do not deem the inoculations dangerous in the sense that the evacuations of the individuals vaccinated may propagate cholera.
- (4) The disturbances which follow the inoculations offer no gravity and do not last more than 36 hours, on which account I believe it harmless, although this opinion may be overthrown because sometimes phlegmons or abscesses may be formed. In upwards of ten thousand inoculations already performed it is only with the rarest exceptions that a few accidents have occurred, such as perhaps in a larger number follow the injections of medicinal substances which the physician daily practices.
- (5) Scientific basis is wanting in order to estimate as probable an anti-choleraic immunity produced by the inoculation of a liquid into the subcutaneous cellular tissue of the arm.
- (6) Numerous statistics are wanting which might prove the existence of such an immunity.

Upon this report Dr. Ferrán comments as follows:

I have already said in an anterior chapter that Dr. Garcia Sola was one of those who signed

\* The following reports are abstracts from Ferrán's book. Loc. Cit.

the report of the commission appointed by the Government. If he presented another on his own account it was in fulfillment of his duty as a delegate of the provincial legislature of Granada.

In this last report there are no contradictions with what was stated in that of the said commission. He solely adds that he had not been able to confirm the morphological details discovered by us, which we are sorry he could not see as well as a colleague of the commission Señor Mendosa, who first and last was able to observe some if not all of them; and he concludes that scientific authority is wanting for the admission of the possibility of a cholera immunity produced by subcutaneous injections.

As we have already occupied ourselves with the solution of these points in diverse parts of this work, we will not repeat here what we have already said.

We are acquainted with the investigations which Dr. Garcia Sola has made in microbiology, whose difficulties he overcomes with assiduity and persistence, and we hope to have him in time a decided follower of our doctrine because the facts will convince him; he is not one of those men influenced by words or oratory, but depends upon the work of the laboratory, which to-morrow will furnish him positive triumphs, if up to the present time unfortunately it has not done so for him.

#### CONCLUSIONS OF THE COMMISSION FROM LINARES.

[Commissioned by the municipality : Drs. Francisco Bautisco, José Avellan, and Antonio Ruiz, chairman.]

(1) That the inoculation is absolutely inoffensive, and the troubles which it provokes are neither grave nor extend beyond forty-eight hours.

(2) The virus is a culture of the comma bacillus.

(3) The excretions of the inoculated do not contain the comma bacillus, and therefore can not propagate the epidemic.

(4) Whenever the danger threatens the inoculation ought to be practiced.

(5) We can affirm nothing definite with respect to its efficiency; it wants the sanction of numerous well-made statistics and to be tried in the crucible of a long and broad experience.

Dr. Ferrán deserves well of his country for his talents and for his important labors in the cause of science and humanity.

(These gentlemen submitted themselves to the inoculation, and speak of what they know.)

(This was the first commission sent to investigate our prophylactic method, on the 17th of May, 1885; naturally, therefore, it abstained from judgment upon the statistics which were then still scarce.)

#### CONCLUSIONS OF THE COMMISSION FROM THE MUNICIPALITY OF SEVILLE.

[Commissioned by the municipality of Seville : Dr. Rafael Tunondelara.]

(1) The disease which extends over the province of Valencia is Asiatic cholera.

(2) The determining cause of the disease being scientifically recognized and investigated, and it being proven that the atmosphere does not take any part in its propagation, the more rational prophylactic measure, and the one in harmony with our actual knowledge, should be isolation and disinfection of persons and contaminating objects.

(3) It being demonstrated by facts that the anti-choleraic vaccination of Dr. Ferrán with an unattenuated virus of the microbe itself does not leave any immunity against the natural disease, and besides it being a prejudice to the public health through the handling of the fluid cultures, it ought to be prohibited entirely.

SEVILLE, July 30, 1885.

Dr. Ferrán remarks: Dr. Tunon remained in Valencia during the whole time that the official commission appointed by the Government remained; he was present at the majority if not at all of the experiments of the said commission; he did not himself perform any labor that we know of; he only witnessed that which his friend Dr. Garcia Sola performed; yet, nevertheless,



from the same premises he deduced conclusions contrary to those of Dr. Garcia Sola and to those of the respectable commission represented there by Don Francisco Alonzo Rubio.

The conception which Dr. Tunon formed deserves to be recognized as a prodigy of logic.

#### CONCLUSIONS OF THE COMMISSION FROM THE PROVINCE OF SEVILLE.

[Commissioned by the honorable provincial legislature of Seville, and Dr. Leopoldo Murga.]

(1) Concerns the character of the reigning disease.

(2) Of the morphology described by Dr. Ferrán concerning the comma bacillus, we have only been able to confirm the form of the comma, the spirillum and presence of spores, oogonia and muriform bodies; we have not seen the exit of the spirillum nor the existence of the cloud, nor the constant existence of the oosphera.

(3) The pathogenic powers of the commas in animals may be considered as an effect perfectly demonstrated.

(4) That the inoculations into the subcutaneous tissue of the animals in a sufficient dose produces an immunity quite marked against successive inoculations of greater quantities.

(5) The symptoms developed by the injection of the pure culture of the comma present in some cases much resemblance to the clinical symptoms of cholera.

(6) The fluid employed for the inoculations consists of a pure culture of the comma bacillus and the technique of its preparation is very simple.

(7) The disturbances which follow the inoculation are not grave, nor do they last more than thirty-six hours on which account we regard it as harmless since in no case of the existing fifty thousand inoculated and one hundred and fifty thousand injections which these represent, has there been a necessity of an amputation of either arm, much less the death of an individual occasioned.

(8) That among all the inoculations unfavorable results lack foundation.

(9) Certain as we are of the absolute truth of these statistics, in the collection of which there has not been the least pressure, and of the report of oppression on the part of the governor of the province of Valencia, we believe that the problem of the anti-choleric inoculation is definitely solved and should occupy a pre-eminent place in the prophylaxis of this disease.

SEVILLE, *October 10, 1885.*

(The author of this report is, without any doubt, one who can speak from the most reliable data, since from the commencement to the end of our prophylactic campaign he has pursued the study with the interest which is natural to one who, like himself, possesses such vast knowledge of micro-biology.)

#### CONCLUSIONS OF THE COMMISSION FROM THE PROVINCE OF ALBACETE.

[Drs. Manuel Furio, Francisco Romero, and Francisco Iniguez de Montoya delegated by the honorable provincial legislature of Albacete.]

(1) That the subject of this study is Asiatic cholera.

(2) That the preventive inoculation of cholera by the method of Dr. Ferrán is absolutely harmless.

(3) That the said inoculations possess a real and positive prophylactic value.

In presenting these conclusions the commission considers that they have performed their duty whilst basing themselves as much as possible upon facts of truly scientific interest.

The subscribers do not wish to end this unpretentious report without rendering a just tribute of admiration as well as of gratitude to the modest, although distinguished, bacteriologist Dr. Jaime Ferrán, who by his profound investigations has raised the science of his country to a great height and rendered to humanity a service worthy of being graven with letters of gold in the pages of the history of our science.

## CONCLUSIONS OF THE COMMISSION FROM THE PROVINCE OF CÓRDOBA.

[Commissioned by the provincial legislature : Drs. Pedro Angel Osuna, Cristobal Garcia.]

These gentlemen having made comparative studies of the march of the epidemic in the villages inoculated and in those which were not, report the following : Conclusions of Dr. Pedro Angel Osuna:

(1) Only the diseases which produce an immunity may possess an artificial vaccine virus; such are anthrax, variola, yellow fever, syphilis, Asiatic cholera, etc.

(2) Immunity does not mean that *any individual* can not experience the same affection twice during his life; neither does it mean that vaccination *absolutely closes the doors of the organism* to the entrance of the disease.

(3) The diseases, which like erysipelas, intermittent fever, tuberculosis, etc., attack the same individual several times, do not and can not possess a vaccine virus.

(4) Asiatic cholera, a bacillar disease in the widest meaning of the word, which produces in an immense majority of cases an immunity at least during one epidemic, *ought to have and does have its vaccine virus*.

These conclusions are at the end of a discourse pronounced by Dr. Osuna before the meeting of the provincial legislature.

Dr. Garcia pronounced another discourse from which we copy the following paragraphs in order that his judgment of the question may be seen:

We already see by these numerical data that there can be nothing so eloquent or so decisive of the question which we are endeavoring to solve.

But, gentlemen, here the anti-Ferránists raise their last effort and seek to destroy the favorable effect which these statistics create for the doctrine. But in what way? Very simply; by saying that they are false. On what ground? But I have sufficient reasons to be convinced of what is a fact; I have heard the echoes of the unanimous opinions of all of those villages and have associated with those confrères who have performed the labor of observation, in order to establish the whole truth by the results where populations saved from desolation and ruin furnish them; I declare most positively that the affirmations of those physicians are worthy of entire credit; neither can it be conceived, except by a mean spirit, that those who have dedicated themselves to the noble practice of medicine are diverted by anything or anybody from aiming at the truth; moreover when we deny these statistics, worthy as they are of credit, in the same manner we can deny everything, even the practical foundation of medicine, without which our science would lose all its value.

It is not possible to comprehend how in so many distinct villages and among so many individuals any one could falsify the data, however much this might be attempted; because it is not logical to suppose that all are blind partisans of this doctrine. In villages where every one is known, and where we know those whom we have cause to be followed for some days it is not possible for such facts to remain hidden, simple as it appears. I believe that if the records of the specific data were not authentic men would not be wanting who would have protested by arraying other facts against those which the statistics declare.

In Alcira, where there is a genuine idolatry for Dr. Ferrán, every one is acquainted with the facts; every one knows the persons mentioned in these statistics, and the exactness of the details has surprised us, substantiated as it is by the words of the patients themselves or by some one of their families.

It is testified with one voice that the most intense focus which existed, the epidemic being already somewhat extensive, was a house, in most miserable hygienic conditions, in which a large number of poor families was lodged in a court called Barracas, wherein the victims were numerous. They attempted to extinguish that focus, and to that end the vaccination was completed there in one afternoon without any one remaining unvaccinated. Very well, with this performance the attacks ceased, and every one saw the immediate effect with astonishment; much greater was this astonishment when on the day of the next feast the four individuals absent in the fields, and on this account not vaccinated, became attacked by cholera and died the same day, the other inhabitants remaining free from the disease up to this date.



In the hospital established in Alcira for the relief of the cholera patients, the whole household, including physicians, sisters of charity, nurses, attendants, and servants were inoculated. The porter alone did not wish to be vaccinated for fear of troubles which he supposed the injection might produce. In a short time the latter died from an attack of cholera, and all of the others continued free from the affection without having suffered the slightest disturbance.

The case of a woman is also worthy of mention who had seen two small children die in a few hours, and who soon saw her last child, eight years of age, attacked with the disease. The unfortunate and despairing mother was lamenting her misfortune in the presence of several persons when the little patient said to her very frankly: "Mother, I am not going to die, I am vaccinated." In fact, in his pocket he had the card of his inoculation, which had been performed without his mother knowing it. On the following day he was convalescent of the disease.

If I were to enumerate all of the really notable cases which have happened there and which have caused Dr. Ferrán to be regarded as their saviour by all, I should never end.

I, gentlemen, in view of all that I have narrated to you, and with the convictions acquired through all that I have learned, I, who have little tendency to investigate without seeing sufficient reason, do not hesitate to-day to declare myself frankly and decidedly a partisan of the doctrine of Dr. Ferrán until other facts shall destroy that which to-day constitutes the foundation of the value of his procedure.

Let us, before concluding, say something concerning the particular symptoms presented by those vaccinated persons who have, although in small numbers as we have shown, been attacked by the disease.

*Coldness.*—This, although somewhat marked, never reaches such a degree of intensity as in the non-inoculated.

*Vomiting.*—It is less in duration and frequency. The duration does not exceed, as a general rule, thirty-six hours; the intensity or the force of expulsion is not so violent, and the time of the interval between the acts of vomiting is greater.

*Diarrhœa.*—In its duration, intensity, and frequency it is less marked. It is not of such a colliquative character nor does the blood reach such a state of inspissation as in the non-inoculated.

*Intoxication.*—It is not intense, and its period is very rapidly passed. The pulse is not lost, although it is small. Naturally and logically, algidity does not reach its maximum grade.

Finally, it ought to be mentioned that the maximum brevity with which all of the morbid phases follow each other and the rapidity of convalescence and recovery very strongly attract attention in the inoculated.

With respect to preventive measures I consider in the first rank the Ferrán inoculation.

#### CONCLUSIONS OF THE COMMISSION FROM THE PROVINCE OF LOGROÑO.

[Commissioned by the honorable provincial legislature of Logroño: Drs. Pelegrin Gonzales del Castillo, Ezequiel Lorza, and Donato Hernandez Onate.]

- (1) That the cause of cholera is the comma bacillus.
- (2) That the entire harmlessness of the anti-choleraic inoculations of which Dr. Ferrán is the author is proven.
- (3) That the culture fluids which he employs for the said inoculations are free from every toxic principle, and the presence of the comma bacillus in them has been demonstrated.
- (4) That the doctrine upon which is based the preventive method against cholera of the said Dr. Ferrán is rational and scientific; and that if indeed the experiments performed up to the present do not allow it to be asserted *absolutely* that the true virus of cholera has been discovered, the practical results already known and sufficiently numerous furnish foundation for the expectation that Dr. Ferrán shall soon be considered as the author of this doctrine.

The logical corollary which should be joined to these deductions is the following: If epidemic cholera should invade our province, our opinion is that the anti-choleraic vaccinations

should be practiced here as much because we are warranted in believing in its prophylactic action so long as the facts continue in its support, as because—its harmlessness being proven—much good will follow from the confidence which it inspires. We are also of the opinion that the inoculation ought not to be performed in villages not invaded, for, although the experimental cholera produced is not contagious, since the existence of the microbe in the dejecta of the inoculated has not been discovered, and the symptom of diarrhœa is almost always wanting, we can not say that the handling of the cultures of the microbe may not be dangerous, and we do not know the duration of the immunity which we seek to produce.

(This supposition, we have already shown, is opposed by very numerous facts which occurred in Tortosa, Barcelona, Valencia, villages in which inoculations were practiced during the past winter without giving origin to the appearance of the disease, as also in the villages of Ondara, Las Cuevas, and La Roda, show its slight foundation.)

#### CONCLUSIONS OF THE COMMISSION FROM LA CORUÑA.

[Delegated by La Coruña : Dr. José Rodríguez Martínez.]

(1) The Ferrán inoculation is a serious, reasonable, and scientific procedure.

(2) It is never prejudicial to the public health, nor can the person inoculated serve as a vehicle for the contagion of cholera.

(3) It does not give an absolute immunity, but it gives a relative immunity, namely: less tendency to attack for those who are vaccinated, and more benignity in the disease when it is suffered.

This is what I believe I have seen, though there are exceptions to these rules. I conclude by the affirmation that my conviction is firm that in case of the unfortunate arrival of cholera in this region, I should request vaccination for my children and my friends and, if the Government should consent, for all of those who might desire to be vaccinated.

Aside from this means of prevention there is very little to be said of the others.

#### CONCLUSIONS OF THE COMMISSION FROM THE PROVINCE OF CIUDAD REAL.

[Delegated by the honorable provincial legislature of Ciudad Real : Doctor Gaspar Fissac, ex-director of modern hygiene, ex-adjunct physician to the Vaccination Institute of Madrid.]

(1) The cycle of evolution of the cholera microbe discovered by Dr. Ferrán is the following: Spirili, oogonia, oospheræ, granules, and muriform bodies.

(2) The inoculation fluid contains the cholera microbe, the results having been very satisfactory.

(3) As I believe that the preventive inoculation against cholera is harmless according to all the statistics, the disease not having been once developed, I consider it beneficial, whether for villages up to the present free from invasion or for those attacked.

#### CONCLUSIONS OF THE COMMISSION FROM THE PROVINCE OF GUIPÚZCOA.

[Delegated by the honorable provincial legislature of Guipúzcoa : Drs. Tomas Acha y Briones and Felix Mechelena.]

(1) We understand that the comma bacillus is the specific cause of cholera.

(2) The morphology which Ferrán assigns to the cholera microbe has not been confirmed by the official Spanish commission, nor apparently by the foreign commissions.

(These gentlemen do not know, doubtless, of the special vote of Senor Mendoza, nor of the book of Van Ermengem.)

(3) We do not undertake to affirm that genuine experimental cholera can be produced by the injection of the comma bacillus into the cellular tissue, whilst this is a micro-organism purely intestinal.

Given a microbe which naturally lives in the intestines, it does not follow that implanted in the cellular tissue it cannot, without permeating the whole of the organism, elaborate a poison. The signers of this report admit that the comma is the cause of cholera. They pos-



sess the evidence that the material which we inject into man and into animals is a pure culture of the comma; they know that after these injections morbid phenomena appear. Then what causes them? Is it not the commas, and what must this *en semble* of symptoms produced by the same agents be called?

(4) The idea of anti-choleraic inoculation is in our opinion rational and scientific.

(5) We have not seen fully demonstrated in animals the prophylactic efficacy of the inoculations of Ferrán.

(The examination of two guinea-pigs injected in the laboratory of San Juan de Dios is sufficient basis for the reporters to say this.)

What are the statistics in man? Why don't they say something—those who, with the commission nominated by the Government, had occasion to study them upon the grounds? Besides, all this we have already answered in our work.)

(6) We consider its application in man entirely harmless.

(7) Its efficacy against cholera in man is yet obscure and problematical.

(What contradictions! How does this harmonize with the fourth conclusion, in which it is said that the vaccination is rational and scientific? If it is rational and scientific, it is not obscure or problematical!)

#### CONCLUSIONS OF THE COMMISSION FROM THE PROVINCE OF SARAGOSSA.

[Delegated by the provincial legislature of Saragossa: Dr. Santiago Ramon Cajal.]

(1) It is very probable that the comma bacillus discovered by Koch in the dejecta and in the intestines of cholera patients may be the specific cause of cholera.

(2) The comma bacillus of Koch is however to be considered as a bacteriacea belonging to the family of spirilli, which lacks spores or resistant forms and is reproduced by fission. The complicated genetic cycle described by Dr. Ferrán has not been confirmed by us.

(3) The choleriginous action of the comma could not be entirely confirmed upon the animals. The experiments by duodenal injections in the guinea-pig are as yet capable to various and contradictory interpretations.

(4) The subcutaneous inoculations in small doses of pure cultures of the comma are harmless in animals and in man. In large doses they produce a special infection, which may even cause death, but they do not cause the development of a symptomological picture of cholera.

(We have already demonstrated how unfounded this manner of reasoning is. It is not sufficient to deny that the comma bacillus and the choleriginous agent is the cause of death, by denying that the symptoms of cholera are not developed by it. For what is the disease which precedes this death in the animals which are injected? See further on what Chauveau thinks of this.)

(5) The animals inoculated with the commas by subcutaneous injections are preserved from the effects of double doses of the culture; but this preservative action does not appear to be systemic, neither is it proved that it extends as far as the intestines and impedes there the development of the choleriginous germs which have reached the intestines by the natural mode of infection.

(This mode of reasoning seems strange to us. It is tantamount to denying immunity by vaccination against anthrax because the microbe is injected into the trachea or into the circulation in order to produce an immunity in the animal.)

From the experiments which this commission performed upon guinea-pigs he concludes:

(1) That experimental cholera in the guinea-pig can not be produced by means of duodenal inoculations with pure cultures of the comma, although injected in large quantities.

(2) That the choleriform symptoms, which develop in certain cases may be the simple result of an accidental contamination, during the operation, by special pathogenic microbes capable of engendering a violent entero-peritonitis. This interpretation explains the inconstancy of those pseudo-choleras, the nature of the intestinal exudate which is not rice-like but is a transparent fibrinous serum, and the preponderancy of the straight bacilli over the commas as well in the intestinal canal as in the blood and pathological fluids.

*THE ANTI-CHOLERAIC INOCULATION IN LA RODA AND IN LA UNION.\**

On account of their interest we publish the clinical reports sent by our confrères of the two towns above named. In these reports facts of great value concerning the action of the comma bacillus are comprised.

That of La Union we insert in abstract for its great length does not permit of anything else.

## LA RODA.

## OBSERVATIONS CONCERNING THE ANTI-CHOLERAIC INOCULATION OF LA RODA.

Few questions, more especially those of a medical character, have awakened and maintained such lively attention as that relating to the prevention of cholera by the method of inoculation discovered by our compatriot, Dr. Ferrán.

We hesitate to again fix public attention upon a subject which many have definitely passed judgment upon, but convinced that only experimentation and above all, facts, are capable of resolving such questions, we shall relate what we have been able to observe in this town, where 1,764 inoculations and 964 re-inoculations were practiced. Let us look at the practical results, allowing the statistics to speak. (In La Roda there was no cholera, as we have said in another place.)

It being impossible to make a thorough study of the physiological phenomena which the inoculated offer, we shall present the clinical data which we were able to collect in 549 persons, whom we have most studiously watched. We should state that in the remainder of the number above mentioned no effects other than those which we shall point out were manifested.

With the object of readily collecting in an orderly manner the data which were observed, sheets were ordered to be printed, which, joined to the registers of Dr. Ferrán, facilitated examination.

The registers of Dr. Ferrán comprise: Registration number, name of the inoculated, his nativity, residence, dwelling, age, profession, and a last column for observations.

Our sheets comprise the following: Registry number, name, social position, habitual state of health, date of inoculation, and the physiological effects of the same divided into local and general, in this manner: local-flegmon, induration; general-anorexia, nausea, vomiting, diarrhoea, polycolia, cramps, headache, delirium, fever with chills or without them, sweating, diuresis.

Not having made a very large number of columns, it was not easy to record all the symptoms which were observed.

Let us begin the enumeration and analysis of the phenomena. Syncope was met with in some individuals. Whether it was due to the impression produced upon the mind by the operation or simply to seeing the operation done, we mention the circumstance of having observed it also in certain subjects some hours after the inoculation, a condition which might be called consecutive syncope, and which has caused us to wonder if it could be looked upon as the result of the depressing action which the choleraic poison exercises upon the circulatory functions.

In the column following that for the usual state of health it is indicated whether or not the latter varied in consequence of the inoculation; but having observed that the latter was entirely harmless, as all of the official commissions which have studied the procedure of Ferrán in Valencia have just unanimously declared, and that the organism was perfectly undisturbed after thirty-six or forty-eight hours, during which time the action of the virus is developed, we decided not to complicate further the already large tabular forms, intending to make a special note of some curious cases of a more or less marked alleviation of chronic troubles.

*Phlegmons or indurations.*—As local phenomena, besides the pain which Dr. Moreno regards as caused by the comma bacillus (pain which although of variable intensity is experienced by almost all of the inoculated, and is accompanied by a great difficulty in movements.

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\*From Ferrán's *La Inoculación Preventiva*. Loc. cit.



of the arms), those which are present with greatest frequency are erythema and œdema, and after the disappearance of these the pain is no longer troublesome.

Respecting the phlegmons, among 5,456 injections only one phlegmon occurred, and this was so circumscribed and benign that there was no necessity for medical assistance for more than one day. Indurations more or less circumscribed, painless in some cases, and somewhat extensive and accompanied by pain in others, were met with in 45 subjects.

*Anorexia*.—This symptom was present in 190 individuals.

*Nausea*.—This symptom was present in 90 cases and offered nothing particularly worthy of mention. The same may be said of the *vomiting*, which 75 individuals experienced.

*Diarrhœa*.—This was present in 30 persons, among whom at the same time 16 were troubled with vomiting, and 5 of the latter with cramps, presenting a complete picture of experimental cholera—a circumstance worthy of remark, many having objected theoretically that the prophylactic virtue of the inoculation could be accepted only when the latter should give rise to the development of more or less modified cholera, whilst in the stools of the inoculated the comma bacillus should be met with; but the said microbe was not found in the stools, a circumstance explained by the fact that the cellular tissue into which the inoculation is made is not a favorable soil for its development, and it succumbs, not, however, before the products in the culture are absorbed, and the chain of symptoms above described is thereby occasioned.

In the real disease itself it is otherwise; the cholera microbe finds in the intestinal tube a fertile soil for its active and vigorous life and its products, accumulating from moment to moment until it dies in the same medium which it has itself created, determine illness and death of the patient if the latter is not prevented by treatment or by the resistance of the individual. So that, leaving out of consideration the modification which the microbe suffers in the cultures of Dr. Ferrán, as also the modifications of the products which are elaborated or excreted, the whole question is reduced to that of quantity, and the protection of the inoculated is due to the habit of resisting certain doses of a known poison on the one side, and on the other to the sterilization of the tissues of the organism by the virulent liquid of the cultures.

*Policolia*.—This was met with in 53 persons. A characteristic of this hyper-secretion of bile, which causes dark green color of the stools, is that its persistence is prolonged for more than a month in some cases.

*Cramps*.—Thirty-seven persons experienced them, principally in the legs.

*Headache*.—This symptom, which presents no extraordinary character, is very common and coincides with the development of fever; it also disappears with the latter.

*Delirium*.—If we have remarked it in our observations, it is because it is ordinarily associated with fever. It has been constantly very light, the mind at times turning upon the inoculation itself, and at others upon more pleasant subjects, singing being occasionally indulged in. One hundred and three experienced it.

*Fever*.—We have separated the cases which began with chills from those which began without them; of the former there were 221 cases recorded, and of the latter 290.

*Perspiration* and *diuresis* announced the disappearance of the fever.

Perspiration was present in 352 subjects; the urine was abundant in 297, the two being almost always augmented together, the increase of perspiration preceding.

We can not pass without mentioning some cases in which the inoculation scarcely produced any effect; among those worthy of special mention are the cases of a few ladies in different stages of pregnancy, who did not experience the slightest trouble, not even in the natural termination of the gravid condition. These cases form a curious contrast with those others in which the same quantity of prophylactic fluid, sometimes inoculated at the same sitting, produced the picture of cholera with all its symptoms more or less accentuated, according to our opinion, because there are different grades of receptivity in different individuals for the pathogenic virus and its protective effects, a receptivity which decreases as the inoculations are repeated, of which fact we have been able to convince ourselves, for besides ten or twelve other persons, we ourselves have been reinoculated for the third and fourth time without experiencing from the last of these inoculations the slightest trouble.

From all our observations, two points of importance may be deduced concerning the history of anti-choleraic vaccination, and which have been the subject of the most opposite opinions; these are that the inoculation is harmless for the individual and for the population among whom it is practiced.

That the inoculation is harmless for the individual the 2,728 inoculations and re-inoculations in subjects of all ages from less than two years to more than eighty, prove in an eloquent manner which leaves no room for doubt; pregnant women almost ready to be confined have not suffered any serious disturbance, once the phenomena which ordinarily accompanied the operation were passed, resuming their habitual physiological or pathological condition. The reliability of this latter observation is established because the subscribers were charged with the duty of rendering the medical assistance to this village. Upon the occurrence of any accident we must have had knowledge of it, either one or the other of us, especially as our attention had been called to this matter.

Is the pathological method of Dr. Ferrán harmless for the villages? This question is answered by saying that in this village, in which inoculations were practiced for the space of a month and a half, beginning on the 1st of August, not a single case of cholera has occurred, although during this time neighboring villages, such as La Gineta, Villarrobledo, Tarazona, Barrax, and others, were invaded.

There is another very curious fact in favor of the immunity to which we would advert. Through family necessity, or for other reasons, there departed from this village entirely free of the epidemic for other villages infected 9 inoculated persons and 8 non-inoculated. Although among the first there were four who gave assistance to cholera patients, no one was attacked by the disease; whilst of the 8 non-inoculated 6 were attacked and 2 died of it. This fact, although perhaps insignificant, is not to be doubted, and it speaks very favorably of the value of the inoculation.

Is it due to the influence of the inoculation that this village has remained free of the epidemic? We do not undertake to affirm this, because, besides that measure, great care was taken to keep the town isolated, the isolation being sustained for a long time. But if we take into account the fact that so many isolated villages have found themselves surprised by the presence of the epidemic, and also that four or five of our inhabitants have been attacked outside of this village—some of them being visited by various persons who were inoculated and believed they had nothing to fear—it may be presumed that, at least in an indirect manner, the inoculation may have contributed towards keeping this village free of the epidemic by lessening the tendency to contagion.

We said at the beginning that we would make separate mention of some individuals whose chronic troubles were ameliorated after the inoculation without it being possible to attribute the alleviation to anything else, and we shall speak of them in conclusion.

Don S. M.: Discharged four or five nephritic calculi without pain. In effect the inoculation, besides relieving diathetic affections which had been experienced for a longer or shorter time, appears to exercise a certain eliminating action, the cited case being a notable example.

Doña P. E.: Dyspeptic, with gastric intolerance almost absolute. After the inoculation the vomiting was completely suspended for a month, improvement being marked. We should say, nevertheless, that after that date the amelioration was not permanent, for vomiting reappeared.

Doña J. E.: An old and painful dyspepsia, accompanied by vomiting; complete and permanent relief.

Don P. E.: Gastralgia; alleviated.

Doña C. L.: Lumbago, anorexia, and repugnance for every kind of food; improvement of appetite and of the illness.

Don A. G.: Epileptiform attacks; improvement.

These cases are the most notable, although there were observed many more, especially among rheumatics and among those who suffered from gastro-intestinal affections.



*Preventive inoculation against cholera (anti-choleric vaccination). Method of Ferrán. La Roda (Albacete).*

Number.	Social position.			Usual state of health.			Phenomena observed.													
							Local.		General.								Fever.		Perspiration.	Diuresis.
	Good.	Fair.	Bad.	Good.	Fair.	Bad.	Phlegmon.	Induration.	Anorexia.	Nausea.	Vomiting.	Diarrhoea.	Policolia.	Cramps.	Cephalalgia.	Delirium.	With chills.	Without chills.		
549 observations.	293	192	64	484	55	10	1	45	190	90	75	36	53	37	334	103	221	290	252	297

MANUEL MARÍN, ENRIQUE DE LA HOZ,  
ANTONIO ESCRIBANO, LEOPOLDO MASSÓ.

LA RODA, December 20, 1885.

#### LA UNION.

[Abstract of the observations collected by Dr. Pasqual Molina.]

#### GENERAL CONSIDERATIONS.

The following is established by facts substantiated by the archives. The results of the inoculation in this town could not be more satisfactory. In the 670 inoculated there was not the slightest accident to complain of. The symptoms observed were those already well known, the greater intensity occurring in children, there being among them some very distinct cases of experimental cholera.

Attention is particularly called to the following :

(1) In the house of the undersigned, where, during the three days while the performance of the inoculation lasted, the cultures were handled according to the technical details recommended by Dr. Ferrán, the slightest accident did not take place.

(2) In the families among whom only a part of the members submitted to inoculation, not the least trouble was observed in those not inoculated.

(3) A considerable number of the inoculated devoted themselves to the assistance of cholera patients, to the laying out of the dead, and the removal of the corpses, without being infected.

(4) Lactating women transmitted with the milk a slight choleraic intoxication to their infants.

(5) Pregnancy in all of its periods constituted no contra-indication for the vaccination against cholera.

(6) All the inoculated persons who were attacked with cholera suffered from the disease very lightly; a spontaneous reaction appeared in a few hours.

(7) In the families among whom only a part of the individuals were inoculated those non-inoculated were just the ones who suffered the greatest number of attacks.

#### ABSTRACTS OF CLINICAL OBSERVATIONS MADE UPON INOCULATED PERSONS DURING THE EIGHT DAYS FOLLOWING THE INOCULATION.

No. 19.\* Celestino Calderon Fructuoso, age 55; merchant. Has suffered from dyspepsia accompanied by anorexia for more than five years. The third day from the inoculation appetite was recovered and normal digestion returned.

No. 21. Andres Teulon Hermosa, age 54; chief of the railway station. For nearly six years has been unable to drink water because it causes uneasiness in the stomach and bowels. After the inoculation he drank as much as he wished without noticing the least trouble.

No. 44. Ana Plaraz Martínez, age 23. Was six months pregnant, but, in spite of having

\* Order of inoculation.

felt severely the effects of the inoculation, did not experience the least trouble respecting her pregnancy.

No. 59. Ramona de Pont Illanas, age 28. Was in the seventh month of pregnancy. Her condition was not altered in consequence of the inoculation.

No. 64. Quintina Boronat Nuñez, age 29. Nursed a child five months old, and upon the following day the general symptoms of the inoculation were noticed in it.

No. 83. Flor Ibáñez Lledó, age 21 years. Eight months pregnant; did not experience the least trouble.

No. 88. Victorina Varela Tomás, 28 years old. Pregnant a few months, but did not experience any trouble in her condition.

No. 105. María Más Sor, age 28. Dismenorrhœa for many years. After the inoculation she menstruated with the greatest ease.

No. 216. Pilar García Carramato, age 35. Vaccinated during the second month of pregnancy; continued without change.

No. 201. María Martínez Guillén, age 35. Inoculated during the first month of pregnancy; proceeded without unusual symptoms.

No. 286. María Calbache Ibáñez, age 28. Was inoculated while nursing a child of 13 months, which in a few hours experienced the general symptoms of the inoculation.

No. 287. Josefa Pérez Fernández. Nursed a child who experienced the general symptoms of the inoculation which its mother had received.

No. 311. Concepción Madrid Rigal, age 27. Inoculated in the eighth month of gestation. The latter proceeded without any alteration.

No. 329. Josefa Manreso Dolz, age 22. Nursed a child of 14 months, and the latter suffered the general symptoms of the inoculation.

No. 351. Rosario Rodríguez Gil, 32 years old. In the first period of gestation experienced very intensely the effects of the inoculation without noticing any change in her condition.

No. 377. María G. Hernández, age 26. Was inoculated while nursing a child of five months, which presented the general symptoms of the inoculation.

No. 464. María Francés López, age 24. Nursed a child of 10 months, which experienced the general symptoms of the inoculation.

No. 467. Ana Sánchez Martínez, age 27. Nursed a child of 11 months, which experienced the general symptoms of the inoculation.

Dr. PASQUAL MOLINA.

LA UNION, *October 30, 1885.*

## SECTION 4.

### OFFICIAL STATISTICS OF THE FERRÁN INOCULATIONS.

#### OFFICIAL STATISTICS OF ANTI-CHOLERAIC INOCULATIONS IN SPANISH VILLAGES.

These official statistics of the anti-choleraic inoculations after the method of Ferrán I deem worthy of introduction into this report in order that those who have no command of the Spanish language but are desirous of obtaining access to original data concerning this important subject may have the recorded facts within their reach. These records, as may be seen by casual examination, bear prima facie evidence of their authenticity and the official nature of their origin. The various documents are printed in the appendix to Dr. Ferrán's book, *La Inoculación Preventiva contra el Cólera Morbo Asiática*, and the following is a close translation of them :

#### ADZANETA.

José María Estivalis Benedito, official surgeon of Adzaneta, in the province of Valencia, judicial district of Albaida, certifies—

That from the 5th day of July last past, when were inoculated by the method of Ferrán a



portion of the inhabitants of this town, the official census of which is 1,552 inhabitants, there were found absent on the above-mentioned day the greater portion of the adult population, more than 800 of them having scattered themselves among the mountains. There remained in the town upwards of 750, of which there were about 680 non-inoculated and 77 inoculated. There were 30 attacks among the non-inoculated, 20 of which were fatal; and there was not a single attack or death, either before or after the 5 days had elapsed since submitting to the method of Ferrán, among the 77 who were inoculated. It should be remarked that none of the inoculated experienced the slightest inconvenience except a slight malaise and pain in the arms during the first 48 hours after the inoculation. There should be mentioned as a noteworthy fact the existence in the family of Don Federico Plá-y-Plá, secretary of the municipality and of the municipal court, of a person who, since the first cases which occurred in this town, on the 22d day of July, had been in continual contact with cholera patients, corpses, and grave-diggers of the town, for he had rendered assistance to the greater part of them, now procuring them succor, and again administering the medicine which had been prescribed; of the five persons who composed this family four, including the secretary, submitted to the method of Ferrán; the one non-inoculated was attacked with cholera on the 11th of July and died upon the 12th; the rest of the family escaped without having experienced the slightest symptoms.

In testimony whereof I have signed these presents at Adzaneta the thirteenth day of September, 1885. (Signed and sealed.) José María Estivalis.

In conformity with the data in possession of this municipality. Adzaneta, 14th of September, 1885. The mayor, Miguel Tormo. The secretary, Federico Plá. (The seal of the municipality is attached.)

In concord with the books of the civil registry in this municipal court. Adzaneta, 15th September, 1885. (Signed), The municipal judge, Vicente Quilis. (There is attached a seal of the municipal court.)

In concord with the death registry of the parish. Adzaneta, 16th September, 1885. The parish priest (signed), Sebastián Domínguez. (Parochial seal attached.)

The undersigned, notary of the College of Valencia, in the district of Albaida, to which appertains the village of Adzaneta, witnesses: That I know the signatures of Don José María Estivalis, official physician of the above-named villages; of Don Miguel Tormo and Don Federico Plá, mayor and secretary of the same; of Don Vicente Quilis, municipal judge, and of Don Sebastián Domínguez, parish priest of said village, and I consider authoritative what appears over their names in the preceding certificate; and the seals, those of the municipality, of the municipal judge, and the parochial church, are the official seals. And for whom it may concern I give these presents, in Albaida, at my residence, the 31st of October, 1885. (Seal.) (Signed and sealed.) Eduardo Lassala y Mercader.

#### ALBAIDA.

Don Juan Bautista Ribas and Don Andrés Monzó, official physicians of the town of Albaida, and Don Fabián Ribas, also resident physician of the same, certify:

That from the fourth day of last July, upon which was inoculated by the method of Ferrán a part of the inhabitants of this town, the statistics of the attacks and deaths from cholera are the following: The number of inhabitants, 3,340; absent a large part of the population; remained, 3,290, of whom 2,620 were not inoculated; 670 were inoculated; of the non-inoculated 205 were attacked and 84 died. Among the inoculated there were 12 attacks before the fifth day, and 3 deaths; there were no attacks after the fifth day.

In testimony whereof we give these presents at Albaida the 24th of August 1885. Juan Bautista Ribas. Fabián Ribas. Andrés Monzó. V° B°. The mayor, Pont. (Seal of the municipality.)

Examined and found in conformity with the parochial books of this my church. Albaida, 14 October, 1885. José Pastor. (Seal of the parish.)

Examined and found in conformity with the books of the civil registry in my charge. Albaida, 14 October, 1885. Vicente Vidal. (Seal of the municipal judge.)

The undersigned, notary of the College of the Province of Valencia, with residence in this town of Albaida, the capital of its district, witnesses: That I know the signatures of Juan Bautista and Don Fabián Ribas y Puchol, physicians of the same, and Don Andrés Monzó y Plá, also physician there, as also those of Don Juan Bautista Pont y Cerdá, mayor of this town, Don José Pastor y Torregrosa, parish priest of the same and arch priest of this district, and Don Vicente Vidal y Moreno, municipal judge of this town, and I consider authoritative that which appears under their respective names in the foregoing certificate and the notes which follow, as also the seals, those of the municipality, the church, and the court. And to all whom it may concern I give these presents in Albaida the 14th of October, 1885. (There is a signature) Eduardo Lassala y Mercader.

#### ALBERIQUE.

Don Ramón García y Berenguer, Don Antonio Ferrer García, Don José Devis Rodríguez, and Don Leopoldo Gómez Part, physicians, the first official, and all in practice in the town of Alberique, certify:

That according to the returns in the municipality concerning the registers of inoculation and other statistics which are kept in this office, as well as in the civil and parochial registers, the following appears:

(1) That the epidemic of Asiatic cholera commenced on the 6th of May, and from that date to the 17th of May there occurred 15 attacks and 6 deaths.

(2) That from the 17th of May to the 16th of June there were 1,188 of our inhabitants who submitted to the prophylactic inoculation of Dr. Ferrán, of whom were inoculated gratuitously 548, because they were poor laborers, as follows:

Inoculated the 17th of May .....	218
Inoculated the 18th of May .....	126
Inoculated from the 19th of May to the 11th of June.....	250
Inoculated on the 12th of June, before the official commission.....	594
Total.....	1,188

Of which 341 were re-inoculated on the 15th and 16th of June.

(3) That from the 17th of May the progress of the epidemic was as indicated by the following table (of which we give here only a résumé):

*Résumé.*—From the 9th to the 16th of May, there were 15 attacks and 6 deaths among the non-inoculated; from the 17th of May to the 21st of June, there were 154 attacks and 65 deaths among the non-inoculated. During this same period there was one attack within the first five days, and one death in the same period among the inoculated; whilst there were after the first five days, 7 attacks and 1 death among the inoculated, there being in the same period 1 attack and no deaths among the re-inoculated. From the 22d of June to 6th of August, there were 66 attacks of the non-inoculated, followed by 26 deaths; and during the same time there were no attacks and no deaths within the five days among the inoculated; whilst there were 3 attacks and no deaths after the first days among the inoculated, and among the re-inoculated during this time there were 4 attacks and no deaths.

Thus it appears that among the non-inoculated, there were in all 235 attacks and 96 deaths; among the inoculated, there were within the first five days 1 attack and 1 death; after the first five days 10 attacks and 1 death; among the re-inoculated there were 5 attacks and no deaths.

Alberique, 21st of August, 1885. Ramón García. Dr. José Devis. Leopoldo Gómez. Antonio Ferrer.

Examined, and the foregoing concords with the registered statistics existing in this municipality. Alberique, 22d August. The mayor, Ricardo Grima. (Seal of the municipality.)

Accords with the Quinque Libri of this parish. Alberique, 23d of August, 1885. The Curé, José María Laviña. (Seal of the parish.)



In accord with the contents of the civil register of this municipal court. Alberique, 25th August. The municipal judge, Louis Grima. (Seal of the court.)

I, the subscriber, notary of the Illustrious College of the Province of Valencia, inhabitant and resident of this town of Alberique, witness: That I know all the signatures and seals of the foregoing, and those of the physicians of this town, and those of the local authorities, ecclesiastical and judicial of the same and regard them as authentic. Alberique, 25th August, 1885. José Balaguer. (There is a signature).

#### ALCALÁ DE CHISVERT.

Don Francisco Ferrer Roig, Don José Cucala Sospedra and Don Francisco Julve Llopis, physicians, inhabitants of this town and in active practice in the same, certify as follows:

(1) That within the town of Alcalá de Chisvert, whose official census is 6,502 inhabitants, the epidemic of Asiatic cholera began on the 26th of last June, there having occurred since the said date up to the 3d of the following July 40 attacks and 10 deaths from the said disease.

(2) That from the 27th of June until the 3d of last July, there submitted themselves to the anti-choleraic inoculation of Dr. Ferrán, more than 298 persons of all clases and social conditions.

(3) That from the 3d of July, above-mentioned, to the 13th of August following, when the epidemic terminated, there occurred in this town 682 deaths from cholera; it being impossible to state with exactness, the number of deaths occurring during that time, because there were only the three above-mentioned physicians charged with the assistance of the sick, and there being besides so intense an epidemic that the time to report the exact number of attacks was wanting, although the number could not well have exceeded 2,500.

(4) That none of the inoculated experienced any unpleasant consequences of the inoculation, any local infections.

(5) That among the persons who submitted in this town to the inoculation of Ferrán, there did not occur more than three attacks of cholera, two of them of benign character and one severe; all three stages having occurred in the latter within the space of a few hours, terminating, however, in a prompt reaction, which permitted the patient to leave the bed the following day.

(6) That among the inoculated there occurred no deaths from cholera.

(7) That in houses of Señors Francisco Ferrer, Fernando Cucula, Pasqual Cucula, and Augustín Danfí, there occurred one attack of cholera, followed by the death of one of the members of each of the said families, precisely the sole persons of them all who had not been inoculated.

(8) That the inoculated rendered to the other members of their respective families, and on many occasions to other families having persons attacked with cholera, the assistance and care which the sick require, without there having resulted any contagion.

(9) That the physicians who certify were all inoculated, having exercised their profession during the said epidemic in this place without observing anything unusual in their health, in spite of the severity of the epidemic, to which the accompanying figures strongly testify; there having occurred only the attack and death of Surgeon Don Antonio Cucala Castellet, who had not been inoculated.

Such is the result of the data in our possession. In testimony whereof we give these presents at Alcalá de Chisvert the 30th of September, 1885. Francisco Ferrer Roig. José Cucala. Francisco Julve Llopis. Vº. Bº. The parochial priest, José Mariá Pons. (The seal of the parish).

Don Pascual Albert, municipal judge of the town of Alcalá de Chisvert: I certify that according to the books of the civil registry in my charge and entries of the dependencies of this municipal administration there does not appear among the deaths any person who submitted to the Ferrán inoculation, that which is set forth in the foregoing certificate of the physicians being true.

In testimony whereof I have given these presents at Alcalá de Chisvert the 2d of October, 1885. Pascual Albert. By order: The secretary, Isidoro Máñez. (Seal of the municipal court).

Don Juan Bautista Ronda y Benimeli, notary of the illustrious College of Valencia, residing in this town, and a native thereof, witnesses: That I know the signatures and seals of Don Francisco Ferrar Roig, Don José Cucala Sospedra, and Don Francisco Julve Llopis, physicians; Don José María Pons, curé of this parish; Don Pascual Albert, municipal judge; and Don Isidoro Mánéz, secretary of the said court, attached at the end of the foregoing certificates, and I consider them authentic.

Alcalá de Chisvert, the 2d of October, 1885. (There is a seal). (There is a signature).  
Juan Ronda.

## ALCIRA.

Don José Ramón Calvo y Pelarda, notary of this illustrious college and an inhabitant, witness: That Don Fernando Angla y García, inhabitant of Valencia, according to a personal schedule No. 70 and 1507, dated at Valencia, 11th of July, 1885, exhibited to me a document of which the following is a literal copy:

The subscribers, members of the medical faculty of Alcira, certify: That the register books of the preventive inoculations against cholera (method of Ferrán) from the 1st of May to the 31st of July show the following data:

[Official census of the population 16,000].

	Number.	Per cent. of census.
Attacks non-inoculated.....	4,950	30.94
Attacks inoculated.....	2,220	13.87
Attacks re-inoculated.....	8,830	55.19
Total.....	16,000	100.00

	Non-inoculated.	Inoculated.	Re-inoculated.
Attacks.....	404	44	55
Per cent. of attacks, which is.....	8.16	1.98	.62
Old.....	198	29	45
Present.....			1
Deaths.....	206	15	9
Mortality to percentage attacks.....	50.99	34.09	16.38
Mortality, percentage of the population, as per census.....	4.161	.675	.101

NOTES.—Seven of the deaths of the inoculated were of attacks within five days from the inoculation. Seventy per cent. of the inoculated belong to the class which, with very rare exceptions, furnished the contingent to the epidemic.

In witness whereof we have affixed our signatures at Alcira, 21st of August, 1885. The medical faculty. (Signed and sealed). Manuel Aliño. Pedro Fontana. Pedro Plá. José Ballester. Severiano Roig Llosá. Francisco Mora. Bernardo Magraner. Antonio Serra. Juan Mizzi. Ramón Marco. José Estruch. By order of Dr. Sociats, Baldomero Ortiz. V°. B°. The mayor, Francisco Just. (Seal of the municipality).

The foregoing concords with the document exhibited which I return again, sealed, to those interested. In testimony whereof I declare that I have affixed my hand and seal. Valencia, 22d August, 1885. José Ramón Calvo. (There is a signature).

## ALGEMESÍ.

Don Benito Ballester Broseta, Don José Viciano Carbonell, Don Salvador Primo Llopis, and Don José Ballester Perales, physicians, the three first official, and all resident and practicing their profession in the town of Algemesí, certify—



That in this town, whose official census is 7,856 inhabitants, the epidemic began the 26th of April. There were registered up to the 16th of May 59 attacks of the said disease and 21 deaths. The population alarmed at the rapid progress of the epidemic, solicited Dr. Ferrán to practice his anti-choleraic inoculations. This was done on the 16th and 17th of May to the number of 893, and on the 23d and 24th of June to 309, which, added to the 893 already performed, made a total of 1,202. There were 623 re-inoculated at the last dates. In order to present clearly the progress of the disease, and to be able to compare the attacks of the inoculated the non-inoculated we will divide the epidemic into three periods. The first extends from the 26th of April, the day of the first attack, to the 16th of May inclusive, when the first inoculations were performed. The second begins from the last date and runs till the 23d of June, when the inoculations were increased and the re-inoculations were practiced. And the third and last period terminates the 10th of August, when the last death occurred.

*First period.*—The attacks and deaths of this period are stated above.

*Second period.*—From the 16th of May to the 23d of June, inclusive, there were 306 attacks and 152 deaths among the non-inoculated; at the same time there were 5 attacks and 1 death among the inoculated within the first five days, and 16 attacks and 4 deaths after the first five days, whilst among the re-inoculated there were no attacks and no deaths.

*Third period.*—From the 24th of June to the 10th of August, inclusive, there were 190 attacks and 136 deaths among the non-inoculated, and among the inoculated there were no attacks and no deaths within the first five days, but 5 attacks and 1 death after the first five days, whilst among the re-inoculated there were 6 attacks and 2 deaths.

Algemesí, September 12, 1885. Benito Ballester. Dr. José Viciano. Salvador Primo. José Ballester.

Examined and in accord with the data in the health office of this municipality. Algemesí, 18th September, 1885. The mayor, Juan Bautista Baldoví. (There is the seal of the municipality.)

Examined and in accord with the entries of the parochial record. The incumbent, Vicente Morell, priest. (There is a seal of the parochial church.)

Examined and compared with the entries of the civil register. Algemesí, 15th Sept. 1885. The municipal judge, Juan Bautista Román. (There is a seal of the municipal court.)

Don Julio Gosálbez, notary of the illustrious College of the Province of Valencia for the district of Alcira, with residence in the town of Algemesí, witness :

That Don Benito Ballester, Don José Viciano, Don Salvador Primo, and Don José Ballester, by whom it appears the foregoing certificate was given, are, the three first, official physicians, and all of them in active practice in this town. The signatures and seals with which they attested are authentic ; as also that Don Juan Bautista Baldoví, Don Vicinti Morell, and Don Juan Bautista Ramón, by whom the same certificate appears to have been examined, are, the first mayor, the second custodian of the archives of the parochial church, and the third municipal judge of the said town, and their signatures and seals appear to be authoritative, they being in possession of their respective charges at the date of signature.

At the requisition of the interested party I give these presents, making note of it in the current index book of this notarial office, which I sign and seal in the aforesaid town of Algemesí, the 13th of October, 1885. (There is a signature.) Julio Gosálbez.

#### ALGINET.

Don Francisco Vizcaya Gregorio y Don Paulino Valiente Ortiz, official physicians in practice in this town, certify :

That the returns of attacks and deaths daily forwarded to the mayoralty and the registers of inoculations by the method of Dr. Ferrán give the following results :

1st. That the cholera epidemic began in this town on the 8th of June of the current year.

2d. That from the 8th of June to the 2d of July there were 720 inhabitants subjected to prophylactic inoculations of Dr. Ferrán at the time and in the manner following :

From June 8 to 14, in Valencia, Alcira, and Benifayó (about).....	25
On the 14th of June, before the official commission.....	208
From the 30th of June to the 2d of July.....	487
Total.....	720

Of these there were re-inoculated on the 30th of June 150.

3d. That the course of the epidemic from its commencement up to the 6th of August was that which is shown in the following table of statistics. The official census of the population is 3,441 inhabitants. From the 8th to the 30th of June there were among the non-inoculated 146 attacks and 39 deaths; and in the same period there were among the inoculated 3 attacks, and no deaths before the 5th day; and no attacks and no deaths after the 5th day; and among the reinoculated 1 attack and no death.

From the 1st to the 7th of July among the non-inoculated there were 96 attacks and 26 deaths; and among the inoculated there were 2 attacks and 2 deaths before the fifth day, and 2 attacks and 1 death after the fifth day; whilst among the reinoculated there was 1 attack and no death.

From the 8th of July to the 6th of August among the non-inoculated there were 48 attacks and 35 deaths; and among the inoculated there was 1 attack and no death during the first five days, and there were 4 attacks and no deaths after the first five days. Among the re-inoculated there were no attacks and no deaths.

*Totals.*—Among the non-inoculated there were altogether 290 attacks and 100 deaths; and among the inoculated there were altogether 6 attacks and 2 deaths during the first five days, and 6 attacks and 1 death after the first five days; whilst among the re-inoculated there was a total of 2 attacks and no death.

4th. From the 6th of August up to date there had occurred neither a new attack nor death.

5th. That the course of the epidemic we had the opportunity to make the following observations :

#### REMARKS.

The first death among the inoculated suffered from a chronic gastro-intestinal catarrh; was attacked within the first four days after inoculation.

The second suffered from a chronic enteritis occasioned by the abuse of alcohol, and died within six days from the inoculation. On the preceding day he continued in the abuse of spirituous drinks; he had constant diarrhœa, and his habitual labor was unusually hard.

The third was affected with venereal ulcers. He was attacked within four days of the inoculation. On the preceding days he had a profuse diarrhœa scarcely without interruption. The inoculated patient who recovered presented a symptomatic picture showing a very slight attack. In none of them was there typhoid reaction, and they rapidly entered into convalescence. The two re-inoculated ended in cure in a few days.

We should not omit to mention the following case, considering its importance:

There was inoculated in the house No. 15 Church Street, Vicente Simó Belda, a carpenter, and his daughter Josefa Simó Mollá, 9 years of age, and not inoculated, his wife Josefa Mollá Ibáñez, and the sons Eugenio and Vicente, of four years and one year of age respectively; in the course of four days the three last died, whilst the two first were unaffected.

Alginet. The 24th of August, 1885. (Signed.) Paulino Valiente. Francisco Vizcaya.

Examined and found in accordance with the foregoing as well as with the registers in this secretariat. Alginet, 25th Aug., 1885. (Signed.) Vº. Bº. The mayor, Peregrín Escutia Greus. The secretary, Francisco Martínez. (There is a seal of the municipality.)

In accordance with the civil registry of this court. Algient, 25th August, 1885. Vº. Bº. Municipal judge, Ambrosio Espert. The secretary, Augustín Masiá. (There is the seal of the municipal court.)



Examined and found in conformity with the data of the parochial register. Alginet, 27th August, 1885. The Cure, José Gil. (There is a parochial seal.)

*Attestation.*—Don Joaquín Botella y Pascual, notary of the illustrious College of Valencia, with residence in this town that belongs to the district of Carlet. Witnesses: That I know the foregoing signatures and seals of Don Francisco Vizcaya y Don Paulino Valentia, Don Peregrín Escutia Greus, Don Francisco Martínez, Don Ambrosio Espert, Don Masiá, and Don José Gil, who are the incumbents of the above charges, and I consider them authentic. In witness whereof I have signed and sealed these in Alginet, the 29th of Aug., 1885. (There is a signature.) Joaquín Botella. (There is a notary's seal.)

#### BÉLGIDA.

Don Fernando Andreu Romero, official physician of Bélgida, judicial district of Albaida, province of Valencia, certifies :

That in this town whose population, according to the official census, is upwards of 1,149 inhabitants, the cholera epidemic began the 18th of June of this year, and that there occurred up to the 5th of July 9 attacks and 5 deaths; at this date 580 inhabitants submitted themselves to the anti-choleraic inoculation of Dr. Ferrán, more than half of them being poor laborers. There was no attack until the 11th of July, and from this day to the 27th of August, when the last case occurred, there were of the 569 non-inoculated 27 attacks and 14 deaths. During the same period of time there occurred among the 580 inoculated 6 attacks and 2 deaths; one of the deaths was in a woman 26 years, married, and who had been suffering with intermittent fever more than half a year, and ultimately with dysentery, on which account her physical condition was not at all satisfactory; in the attacks among the inoculated followed by recovery there was no necessity to administer any medicine, since reaction occurred in a few minutes after the attack. In none of the inoculated, or of the 450 re-inoculated on the 10th of August, did a local or general accident happened except a slight circumscribed inflammation in the arm of one of the re-inoculated, which terminated in a very small point of suppuration.

The following notable occurrences in this locality may be mentioned:

In the families of Ramon Durá Tormo, inhabiting Abadía street, and of José Escribá Grau, in San Antonio street, both laborers in the fields, each family consisting of eight individuals, seven of them inoculated and one not inoculated, the two latter were attacked and died, the rest of the family remaining unaffected.

In the family of Esteban Reig Soler, laborer, an inhabitant on Arriba Square, consisting of four persons, two of them inoculated, one of the non-inoculated was attacked and died, the others remaining unaffected. In witness whereof I have given these presents, which I signed, at Bélgida, the 6th of October, 1885. Signed and sealed. Fernando Andreu Romero.

Examined and found in conformity with the data existing in this municipality. The mayor, Santiago Aracil. The secretary, Juan Martínez. (There is a seal of the municipality.)

In conformity with the data in the civil registry of this municipal court. Bélgida, 8th of October, 1885. The municipal judge, Lorenzo Giner. (There is a seal of the municipal court.)

In conformity with the parochial registers of this town. Bélgida, 9th of October, 1885. Vicente Domingo Ares. (There is a parochial seal.)

The undersigned, notary of the college of the province, Valiente, in the district of Abieda, to which appertains the town of Bélgida, witnesses: That I know the signatures of Don Fernando Andrau Romero, official physician of the said town, Santiago Arcil, and of Don Juan Martínez, mayor and secretary of the same; Don Lorenzo Giner, municipal judge, and of Don Vicenta Domingo Ares, parochial cure of the above-mentioned town, and I consider authentic that which has been set forth in the preceding certificate and the notes attached thereto, and the seals of the municipality, municipal court, and parochial church. For those whom it may concern I give these presents in Albaida, my residence, the 16th of October, 1885. (There is a signature). Eduardo Lassala y Mercader.

## BENIFAYÓ.

Don Ignacio Llerandi, Don Juan Galvañ, and Don Vicente Hernández, physicians in the town of Benifayó de Espioca, certify:

That in this place, whose official census is 3,615 inhabitants, the first attack of cholera occurred on the 1<sup>st</sup> of May of the present year; at that date none of the inhabitants had submitted to the preventive inoculation of Dr. Ferrán, but very soon they began to go to Alcira, Alghemesí, and Valencia to be inoculated, so that upon the 21<sup>st</sup> of June there were in this town 408 persons inoculated by Dr. Ferrán, of which 225 were re-inoculated; the remainder, that is 3,207, were not inoculated.

From the 10<sup>th</sup> of May, when the first attack occurred, to the 21<sup>st</sup> of June there were 138 attacks and 89 deaths, without there being attack or death among the persons inoculated.

The course of the epidemic from the date above mentioned (21<sup>st</sup> of June) is as follows:

From the 21<sup>st</sup> to the 30<sup>th</sup> of June, inclusive, there were 119 attacks and 71 deaths among the non-inoculated, whilst among the inoculated there was one attack and no death, and among the re-inoculated there was neither attack nor death.

*Observations.*—At the commencement of this period the official census of the population could be divided as follows: Non-inoculated 3,118, inoculated 408; deaths from the 10<sup>th</sup> of May to the 20<sup>th</sup> of June, inclusive, 89; total 3,615.

On the 28<sup>th</sup>, 29<sup>th</sup>, and 30<sup>th</sup> there were inoculated 2,315.

In the five days following the 30<sup>th</sup> of June, when the 2,315 inoculations above mentioned were completed, that is to say, during the period which Dr. Ferrán indicated in his notes as necessary to produce immunity, the course of the epidemic was as follows:

From the 1<sup>st</sup> to the 5<sup>th</sup> of July, inclusive, there were 18 attacks and 17 deaths among the non-inoculated, whilst there were 21 attacks and 6 deaths among the inoculated, there being neither attack nor death among the re-inoculated.

*Observations.*—At the commencement of this period the official population may be divided as follows: Inoculated, 2,723; non-inoculated, 732; deaths up to the 30<sup>th</sup> of June, 160; total, 3,615.

*Note.*—Of the 6 deaths among the inoculated, 4 had premonitory diarrhoea at the time of the inoculation.

From the 6<sup>th</sup> day of July, that is, after the first five days from inoculation, the epidemic followed the following course:

From the 6<sup>th</sup> to the 27<sup>th</sup> of July, inclusive, there were 8 attacks and 9 deaths among the non-inoculated, and among the inoculated there was 1 and no death; among the re-inoculated neither attack nor death.

*Observations.*—At the commencement of this period the official census could be divided thus: Inoculated, 2,717; non-inoculated, 715; deaths from the 10<sup>th</sup> of May to the 5<sup>th</sup> of July, of the non-inoculated, 177, of the inoculated, 6—total, 3,615.

*Résumé.*—Attacks of the non-inoculated, 283; of the inoculated, 23; of the re-inoculated, none; total, 306.

Deaths of the non-inoculated, 186; of the inoculated, 6; of the re-inoculated, none; total, 192.

Benifayó de Espioca, 28 July, 1885. Ignacio Llerandi. Juan Galvañ. Vicente Hernández.

Examined, and in conformity with the records of the health office of this municipality. The mayor, Domingo Greus. (Seal of the municipality.)

Examined at the civil registry, and found in conformity therewith, as respects the number of deaths and the days upon which they occurred. Municipal judge, Salvadore Clerique. (Seal of the court.)

Examined, and in conformity with the parochial registers. The parochial curé, Juan Domínguez. (Seal of the parish.)

## BELLREGART.

Don Manuel Bordás Gironés, official physician of Bellregart, and Don Martín Gay Mulet, resident practicing physician, certify:



That from the registry books of the anti-choleraic inoculations (method of Ferrán), and from the data in possession of the municipality, it appears:

(1) In this town, whose official census is 2,302 inhabitants, the epidemic of cholera began the 15th of April, when 2 attacks occurred; there being no new cases at all until the 29th of said month.

(2) From the 29th of April to the 20th of May there occurred 178 attacks of cholera, followed by 63 deaths.

(3) The 20th of May there came to this town Dr. Ferrán, as commissioned by the governor, with the object of taking such sanitary measures as he thought advisable, by performing preventive inoculations in 312 individuals.

(4) The inoculations by the method of Ferrán were followed by no local or general disturbances worthy of mention, the subjects enjoying up to the present enviable health.

(5) From the 20th of May, when the inoculations of Ferrán were practiced, to the 20th of June there was not registered a single case of attack of cholera.

(6) From the 20th of June to the 1st of August there occurred 15 attacks and 5 deaths in persons non-inoculated; and one attack, followed by death, in a person inoculated.

(7) The inoculated person who died, Joaquin Giner Canet, was 59 years old, had dyspepsia for ten years; his constitution was so impoverished that it was impossible for him to devote himself to any habitual occupation.

In witness whereof we give these presents at Bellregart the 6th of October, 1885. Dr. Manuel Bordás. Martín Gay Mulet.

The foregoing certificate examined, and found in entire conformity with the facts in possession of the secretariat of the municipality. Bellregart, 7th October, 1885. The secretary, Pasqual Ascó. Vº. Bº. The mayor, José Carbonell. (Seal of the municipality.)

Foregoing certificate examined, and found in entire conformity with the entries in the civil register of this municipal court. Bellregart, 7th of October, 1885. The municipal judge, Rosendo Barberá. (Seal of the municipal court.)

In conformity with the Quince-Libri of this province. Bellregart, 7th October, 1885. Dionisio Esteve, curé. (There is a seal of the parish.)

The undersigned, notary of the illustrious College of Valencia, notarial district of Gandía, with residence in the same, witness: That I recognize the signatures of Dr. Manuel Bordás and Don Martín Gay Mulet, physicians of Bellregart; and of Don José Carbonell, mayor; and of Don Rosendo Barberá, municipal judge of said town; of the municipal secretary, Pasqual Ascó; and of Dionisio Esteve, curé of the same town; and I regard as authentic the statements of the foregoing document. Gandía, 10th November, 1885. Pasqual Sanz. (There is a signature.)

The undersigned, notaries of the College of Valencia, notarial district of Gandía, declare as authentic the sign, signature, and seal of the above-mentioned notary of this city, Don Pasqual Sanz, who recognizes an instrument dated the 10th instant, as above, and seals the same, thus attesting the signatures of Dr. Manuel Bordás and Don Martín Gay Mulet, physicians of Bellregart; of Don José Carbonell, mayor; of Don Rosendo Barberá, municipal judge of the said town; of the secretary of Carbonell, Don Pasqual Ascó; and of Dionisio Esteve, curé of the said town. Gandía, 14th November, 1885. Francisco Aragonés. (There is a sign.) José María García. (There is a sign.) (There is a seal of attestation.)

#### CASTELLÓN DE LA PLANA.

The undersigned, physicians, practicing and residing in this municipality, certify:

(1) That this city, whose population is 28,000, was invaded by Asiatic cholera the 19th of June, 1885, the epidemic having persisted until the 28th of August, of the same year, and occasioning 521 attacks and 300 deaths, according to the official register.

(2) That from the 26th of June to the 5th of July, there submitted to the Ferrán inoculation 648 individuals, of whom 500 were re-inoculated.

(3) That in none of the inoculated were there any local or general disturbances requiring medical assistance.

(4) That during the period of the epidemic there were only two attacks among those inoculated, and the disease presented itself in them under a benign form, convalescence soon following.

In witness whereof we have given these presents at Castellon, the 30th of September, 1885. José Clará, Antidio Desbartrán, M. Sánchez, Nicolás Roig, A. Piug Gasulla, Agustín Segarra, Francisco Rambla, José Cazador. Francisco Jimeno, Nicolás Forés, Francisco Esteve, Joaquín Fabregat, José Segura, Pedro Aliaga, Eduardo Portalés, Félix Roig.

## CATARROJA.

The undersigned physicians practicing in this town of Catarroja, province of Valencia, certify :

That on the 12th of June last there occurred in this municipality, whose official census is 5,521 inhabitants, the first attack of Asiatic cholera followed by the death of the patient on the same day, no new cases occurring until the 18th of the same month, from which date the epidemic began, the course of which is expressed as follows :

From the 18th to the 30th of June, inclusive, there were 219 attacks and 88 deaths.

In view of the frightful increase of the epidemic Dr. Ferrán was solicited to practice his system of prophylaxis, and, under his direction, we practiced the hypodermic injections with the vaccination fluid sent by Dr. Ferrán upon 319 persons, after which the epidemic pursued the following course :

From the first of July to the 5th of August, inclusive, there were 311 attacks among the non-inoculated and 222 deaths; whilst among the inoculated there were 47 attacks and 22 deaths within the first five days from the inoculation, and after the first five days there were among them 13 attacks and 3 deaths.

In testimony whereof we sign these presents at Catarroja, the 6th of August, 1885. Gregorio Llorca. Francisco Sanchis. Ramón Muñoz.

Don Salvador Pechuán Martí, mayor of Catarroja, certify : That the official census of this town is 5,475 inhabitants, and that the number of attacks and deaths named in the foregoing certificate is in conformity with the sanitary record of this municipality.

In witness whereof I give these presents at Catarroja the 15th of August, 1885. Salvador Pechuán. (Seal of the municipality.)

Don José Alós Alapont, municipal judge of the town of Catarroja, certify : That by the civil registry in my charge it appears that the foregoing statistics are in entire conformity with the record of attacks and deaths.

In witness whereof I give these presents, which I sign and seal in Catarroja the 16th day of August, 1885. José Alós. (Seal of the court.)

## CERVERA.

The undersigned members of the council and of the board of health of this town certify :

That, having unanimously agreed on the 5th instant to invite Dr. Ferrán to practice his preventive inoculation against cholera upon numerous inhabitants of this town who desire it, the said doctor with two of his assistants came upon the 21st instant, and having awaited for five days here the commission charged to witness and report upon the results of the experiments, he had to desist in consequence of orders from the president of the commission, who did not believe it opportune to practice the inoculations in this town. Dr. Ferrán appreciated the necessity of obeying this order. The news was received by the village with manifestations of disgust; they begged Dr. Ferrán to proceed with the inoculation; the said gentleman having acceded, he announced the opening of the register in the presence of the president and secretary of this *junta* and of the municipal judge; the inoculations were practiced upon 530 individuals of every age and condition by Dr. Ferrán in person, assisted by Drs. Segarra and Clará, physicians of Castellón de la Plana.

In witness whereof I give these presents, at Cervera, the 24th of August, 1885. (The seal of the municipality.) Signatures follow.



This is a copy of the original contained in the archives of the office. 1st lieut. mayor, Pascual Sorlí. The secretary of the council, José Cervera.

Don Pedro José Tomás Monferrer, physician practicing in this town of Cervera, judicial district of San Matéo, province of Castellón, certify:

That in this town, whose official census is 2,188, the epidemic began the 22nd of July last, observing the following course:

From the 22nd of July to the 23rd of August there were 121 attacks and 60 deaths.

The 5th of August the council and board of health determined to invite Dr. Jaime Ferrán to come to this place and practice his prophylactic method of preventive inoculations, and said gentleman presented himself to perform them on the 23rd, 24th, and 25th of said month, and that 530 were inoculated.

The course of the epidemic after the inoculation was as follows:

From the 24th of August to the 7th of September there were 22 attacks and 12 deaths among the non-inoculated, whilst within the first five days after the inoculation there was one attack and no deaths among the inoculated, and after the first five days there was one attack and no death among them.

There was no complication caused by the inoculation among those inoculated.

In witness whereof I have given these presents at Cervera the first of November, 1885. Pedro J. Tomás.

Examined and found in conformity with the records in this municipality, Cervera, 1st November, 1885. The mayor, Sebastián Ballester. (The seal of the municipality.)

Examined and in conformity with the entries in the civil register. Cervera, 1st November, 1885. The municipal judge, Juan Ramón Ayza. (The municipal seal.)

Examined and in conformity with the records of the parish. Cervera, 1st November, 1885. The curé of the parish, Higinio Ribera. (Seal of the parish.)

The undersigned, notary of the College of Valencia, with residence in the town of San Matéo, witnesseth:

That I consider authentic and hold as indubitable the signatures and seals which attest the foregoing certificates of Don Pedro José Tomás, physician of Cervera, and of the mayor, the municipal judge, and curé of the parish. In witness whereof I give these presents at San Matéo, the 12th of November, of the year above mentioned. (There is a sign.) Rafael Peñalva.

#### CHESTE.

The undersigned physicians, practicing in the town of Cheste, certify:

That in this town, whose official census is 5,227, the epidemic was officially declared on the 16th of June last, and that it pursued the following course:

From the 15th to the 30th of June, inclusive, there were 175 attacks and 65 deaths.

In view of the fearful increase in the number of attacks the board of health determined to invite Dr. Jaime Ferrán to come and practice his prophylactic method of preventive inoculations, and in fact these were practiced on the 30th of June, the 1st and 3rd of July, the number of inoculated being 3,136.

The following is the course of the epidemic after the inoculation:

From the 1st of July to the 8th of August, inclusive, there were 76 attacks and 35 deaths among the non-inoculated; and 13 attacks and 7 deaths among the inoculated within the first five days from the inoculations, whilst there were no attacks and no deaths after the first five days among the latter.

In witness whereof we sign these presents at Cheste the 9th of August, 1885. Dr. Rafael Martínez Seguí. Genaro Sabater.

Examined and found in conformity with the records of the board of health of this municipality. Cheste, 10 of August, 1885. The mayor, Antonio Lavarias. (Seal of the municipality.)

Examined and in conformity with the entries in the civil register. Cheste, 10 August, 1885. The municipal judge, José Marín. (Seal of the court.)

Examined and in conformity with the entries in the parish book. Cheste, 14th August, 1885. Parochial curé, Doctor Eduardo Gil. (Seal of the parish.)

Don Juan Bautista Marques y Fenollera, notary of the college of the district of the court of Valencia, resident of the town of Cheste, notarial district of Chiva, testify: That the said Genaro Sabater and Dr. Rafael Martínez Seguí, by whom the foregoing certificate appears to have been given, are physicians practicing in this town and the signatures and seals attached appear to be genuine, and that the said Genaro Sabater, Dr. Rafael Martínez Seguí, and Don Antonio Lavarias, Don José Marín, and Dr. Eduardo Gil, by whom the same certificate appears to have been examined, are, the first, mayor, the second, municipal judge, and the third, parochial curé of this town, and the signatures and seals appear to be authentic.

For whom it may concern I give these presents, signed and sealed in Cheste, the 16th of August, 1885. Juan Bautista Marques. (There is a sign.)

## CHIVA.

Don Manuel Silvestre and Don Peregrín Lanuza, physicians practicing in the town of Chiva, certify:

That in this town, whose official census is 4,386 inhabitants, the attacks of Asiatic cholera commenced the 15th of June, from which date to the 29th of the same month 127 of the inhabitants submitted themselves to the anti-choleraic inoculation of Dr. Ferrán, going for that purpose to Valencia. From the 15th to the 29th of the said month there were only four attacks, all followed by death, and before this, the unusual gravity which all these cases presented caused a large number of the inhabitants to solicit Dr. Ferrán to come and practice his preventive inoculations. This was done on the 29th and 30th of June to the number of 1,181, which, added to the 127 previously inoculated, constitute a total of 1,308 inoculated up to the date of the 30th of June.

The following is the course of the epidemic from this date:

From the 29th of June to the 10th of August, inclusive, there were among the non-inoculated 140 attacks and 54 deaths, and among the inoculated 11 attacks and 5 deaths.

*Remarks.*—1st. Twenty-seven of the attacked are at present in the condition of convalescence.

2nd. The two deaths of the inoculated which occurred on the 3rd and 4th of July took place before the termination of the period of five days which Dr. Ferrán announces in his notices as necessary for the development of the disease, which may be in the period of incubation, as for the physiological evolution of the inoculated liquid.

3rd. The inoculation being suspended by official order, re-inoculation, which Dr. Ferrán deems indispensable to make the protection complete, could not take place.

In testimony whereof we sign these presents at Chiva, the 10th of August, 1885. Manuel Silvestre. Peregrín Lanuza.

Examined and found in conformity with the records in the health office of this municipality. Chiva, 10th August, 1885. The mayor, Francisco Estala. (Seal of the municipality.)

Examined and in conformity with the entries of the civil register. The municipal judge, Severino Salvo. (Seal of the court.)

Examined and in conformity with the records of the parish. The parochial curé, Romualdo Delgado. (Seal of the parish.)

Don José Redondo y Ferrer, notary of the illustrious College of Valencia, with residence in this town of Chiva, of which he is a native, notarial district of the same, testify: That I know the signatures of Don Manuel Silvestre, Don Peregrín Lanuza, physicians; Don Francisco Estala y García, mayor; Don Severino Salvo y García, municipal judge, and Don Romualdo Delgado y Ruíz, parish curé, all of this town, and consider authentic the averments of the foregoing documents.

And in testimony thereof I sign and seal these presents at Chiva, the 14th of August, 1885. José Redondo. (There is a sign.)



## CUEVAS DE VINROMÁ.

The undersigned, licentiates in medicine and surgery, residing in this town, certify:

That the 8th of September last past, the assistants of Dr. Ferrán being here, there were performed 315 inoculations with the anti-choleraic liquid of the said doctor; the 16th of the same month by the same assistants of the said doctor 232 inoculations were performed, and on the 17th of the same month there were 386 re-inoculations in this manner—314 of the inoculated from the 16th and 72 of the inoculated in Alcalá de Chisvert the 3rd of July; that neither in the inoculated nor in the re-inoculated have we observed or heard that any local or general disturbances supervened.

In witness whereof we, the two physicians residing in this locality, have given these presents at Cuevas de Vinromá the 15th of October, 1885. Francisco Vaquer. Francisco Granell.

Don José Lucía Mesquita, notary of the illustrious College of Valencia, with residence and nativity at Cuevas de Vinromá, testify: That the foregoing signatures and seals are apparently from the hand and pen of Don Francisco Vaquer Albella and Don Francisco Granell Martí, physicians practicing in this town, and for that reason I consider them authentic. And at the request of those interested I give these presents, which I sign and seal at Cuevas de Vinromá, the 16th of October, 1885. (There is a sign.) Signed. José Lucía.

(In this town the cholera did not appear either before or after the inoculation.)

## LA ELIANA.

Sr. D. JAIME FERRÁN:

MY DEAR SIR: Answering your communication in which you ask for information concerning the preventive inoculation against cholera in this place, I must tell you that in this agricultural population there are 100 or perhaps 500 inhabitants, more or less, and it is surrounded by the villages Ribarroja, Burjasot, Villamarchate, and la Puebla. In all of them epidemic cholera raged, and in our population we had seven attacks and three deaths, when we applied to you for the purpose of submitting ourselves to your prophylactic inoculations. These were performed the 4th of July to the number of 51 without producing any accident.

After that date there were seven attacks, three followed by death, one of these in a woman who at the time of her inoculation was suffering for three days with diarrhoea, and it was at once stated to her family that the inoculation would be a remedy and not a preventive. Of the six other attacks none occurred in houses or families of the inoculated.

Entrance and exit in La Eliana, and therefore contact of its inhabitants with those of the neighboring infected villages, was entirely free before and after the inoculations were performed.

I remained with my family in this place during the whole epidemic, for which reason I could closely follow all that occurred here, and I can furnish you whatever other information you may desire from here if this is not sufficient.

I take pleasure on this occasion in offering myself as your faithful and affectionate servant, Q. B. S. M., The Marquis of Casa Ramos. Agricultural colony "La Eliana," 10th October, 1885.

## LA RODA.

Don Enrique de la Hoz Fernández, Don Antonio Escrabano Moreno, Don Leopoldo Massó Pastor, and Don Manuel Marín Sevilla, physicians, the first official, and all residing and practicing in La Roda, province of Albacete, certify:

1st. That the epidemic of Asiatic cholera having developed with some severity in various places of the peninsula during the past year, 1885, there was a rigorous sanitary cordon established in this town, which, preventing contact, diminished the probabilities of contagion and prevented the unfortunate consequences which the town experienced by reason of the said disease in the past epidemics of 1834 and 1855.

2nd. That upon the anti-choleraic inoculations of Ferrán being declared harmless by the distinguished official commission appointed to investigate them, and the danger of this town

increasing by reason of the invasion of the capital and other neighboring villages, such as La Gineta, Villarrobedo, Tarazona, and others, the proposition to submit to the said inoculation found support among the inhabitants of this town, and favored by Dr. Jaime Ferrán with the liquids and necessary instructions, the inoculation was proceeded with, there having been 1,764 inoculated and 964 re-inoculated, belonging to all social conditions and of ages from less than two years to more than eighty.

3rd. That in none of the 2,728 operations performed did there supervene accidents or complications apart from the known and transient local and general disturbances, the 5,456 injections not having occasioned more than one single phlegmon, and this so circumscribed and benign that attention was unnecessary for more than one day.

4th. Contrary to the opinion entertained by some, that, if indeed those inoculated by the system of Ferrán enjoy immunity, it is at the cost of a greater danger for those who do not enjoy it, because the inoculated form a focus of dissemination of the choleraic infection, there has not appeared a single case of invasion in this town after the inoculations were performed.

5th. That from family necessity or other reasons nine inoculated and eight non-inoculated persons left this town, then entirely free of the epidemic, for other places infested; and although among the first there were four who gave attention to cholera patients, none of them were attacked with the disease, whilst of the eight non-inoculated six were attacked and two died. (The names and conditions of these 16 persons are set forth in the document.)

In testimony of the foregoing, the truth of which has not been ascertained by us personally, we signed these presents at La Roda on the 2nd of January, 1886. Antonio Escribano. Enrique de la Hoz. Manuel Marín. Leopoldo Massó.

Don Federico Atienza Jimenez, advocate of the royal courts, municipal judge of this town of La Roda, and custodian of the civil register of the same, certifies that, having carefully examined the register of deaths in this town corresponding to the past year, 1885, there does not appear any death produced by cholera Asiatica.

In witness whereof I have given these presents at La Roda, 2nd of January, 1886. Federico Atienza, P. S. M., Juan Toboz, secretary. (There is a seal of the court.)

#### LA UNION.

Don Pasqual Molina Núñez, licentiate in medicine, official physician of this town, subdelegate of this district, member of the Academy of Medicine at Carthage, etc., certify:

That Asiatic cholera was officially announced in this town the 27th of last June, and Dr. Jaime Ferrán, having been solicited to practice his system of preventive inoculation against the said disease, the said gentleman sent as his representative Dr. Juan Torres y Babi, of Valencia, there being inoculated by him and the subscriber during the 3d, 4th, and 5th of July 572 persons, whose names, age, sex, domicile, and other conditions are set forth in the register, which was opened for that purpose.

In the inoculated the general phenomena already well known were observed, such as pain in the arms, fever, loss of appetite, etc., more or less marked, some presenting the syndromes of an experimental or attenuated cholera, but without their occurring in any of the 572 inoculated phlegmons or other morbid complications, the following circumstances being worthy of mention:

1st. A few of the persons inoculated had just suffered other diseases, but no exacerbation was observed. On the contrary, there may be cited the cases of Celestino Calderón Fructuoso, and Don Andrés Teulón Hermosa (numbered 19 and 21 of the register of inoculations), who had for five or six years been suffering with chronic dyspepsia, and of María Mas Sor (No. 105 of the register) with very intense chronic dysmenorrhoea; the two first, as by enchantment, saw their digestive functions become regulated, and the third experienced a spontaneous re-establishment of the catamenial flow during the three or four days after the anti-choleraic inoculation was performed.

2nd. The pregnant women who submitted to the inoculation were numerous, and in various periods of gestation (some at the end of the eighth month), and in none of them was the slightest disturbance produced.



3rd. In the pregnant who were inoculated through fear no other than the customary phenomena appeared, such as pain, slight fever, etc.; and in the children nursed by them, and not subjected to the inoculation, the same symptoms observed as in the mothers or nurses were seen.

The official total of attacks during the epidemic in this town, whose census is 22,000 inhabitants, was 1,081, furnishing 509 deaths, none of the latter among the 572 inoculated, and there were only the following six attacks among the latter :

1st. Don José Teulón Viso (No. 108 of the register), 21 years of age, employé, native of Carthagena, inhabitant of this town, Mayor st., was attacked the 15th of Aug. (40 days after inoculation), suffering with diarrhœa, vomiting, slight cramps, thirst, coldness, and prostration, in a few hours, and without any treatment than the infusions of tea and a few drops of laudanum, reaction occurred, immediately followed by convalescence.

2nd. Bartolomé Martínez Ruíz (No. 254 of the register), 25 years of age, carpenter, native of Huécar, an inhabitant of this town, Real st.: attacked 24th day of July (21 days after inoculation); almost the same symptoms as in the previous case were noted, reaction occurring in a few hours without the necessity of medical assistance.

3rd. Juan Correoso García (No. 267 of the register), 28 years of age, servant, native of Almería, inhabitant of this town, in the tram-way station, was attacked the 5th of Aug. (a month after inoculation) with severe diarrhœa; there being no water-closet in the house, he went out naked to an adjoining passage-way, fell from weakness, and could not return; he was brought in after a rat had gnawed him (it was late in the night), and given infusions of tea and a few drops of laudanum when he entered into reaction; the physician came a few hours later but found further assistance unnecessary.

4th. Pedro Díaz Montiel (No. 441 of the register), four years old, inhabitant of this town, Angel st.: attacked the 30th of July (25 days after inoculation) with incipient diarrhœa, vomiting, and other symptoms common to the disease; without other remedies than rest and sudorific infusions, in a few hours he experienced a rapid reaction.

5th. Francisco Cánovas del Aguila (No. 448 of the register), 37 years old, miner, house in Educacion st. Performing acts of heroism among the 120 attacked, and more than 60 corpses in a small depopulated district by rendering assistance to the first and interring the second, he was himself attacked the 24th of July in the fields and brought to his home by two men who themselves had premonitory symptoms; in a few hours he experienced the three stages of cholera, entering upon convalescence without other treatment than shelter and laudanum.

6th. Isabel Martínez (No. 471 of the register), 40 years old, inhabitant of this town: attacked the 6th of Sept.; without experiencing any grave symptoms, she entered into a prompt reaction; the child whom she nursed did not experience anything unusual when the mother was inoculated.

The foregoing is personally known to me with absolute certainty by reason of my duties. From what has been related and from other details, which for brevity's sake I have omitted, I affirm that I conceive that the system of inoculations by Dr. Jamie Ferrán is highly prophylactic and beneficial.

In testimony whereof I sign these presents at La Union 1st of Sept., 1885. Licentiate, Pasqual Molina.

The undersigned inhabitants of this town declare that we regard as true the statements in the foregoing document attested by the signature of the physician of this town, Don Pasqual Molina Núñez; and in order that the effects of the anti-choleraic inoculation of Dr. Ferrán in this town may be shown to be real and proven to be harmless, we sign these at La Union the 3d day of Nov., 1885. E. Charques. José Jiménez. Francisco Tomás. Bibiano Asencio. Alfonso Ros. J. Manuel Flores Orceto. Tomás Manzanares. Francisco Pujol. D. Martínez.

Don José María Sánchez, curé of the parish of Alumbres, with residence in La Union, certify:

That the parochial register of the archives in my church do not contain an entry of any death of the 570 individuals who were inoculated in this town by the method of Ferrán during the last epidemic.

Likewise I certify that according to the data in this municipality there were 1,081 attacks and 509 deaths from cholera.

At the request of Don Pasqual Molina, licentiate in medicine and surgery of this town, I give these presents, which I sign and seal at La Union the 10th of Nov., 1885. José María Sánchez. (Seal of the parish.)

Don Andrés Lorente Valcárcel, advocate and municipal judge of this town, certify:

That upon examination of the indices of the death record in this civil registry there does not appear to have been any death from epidemic cholera in this town among the persons named in the list exhibited by Don Pasqual Molina Núñez.

And in testimony whereof, at the instance of the said Señor Molina, I give these presents, which I sign at La Union the 11th of Nov., 1885. Andrés Lorente. The secretary, José María Teuchaud. (There is a seal of the municipal court.)

I, the undersigned notary of the Illustrious College of Albacete, of this town, witness, that I know the signatures of Don Andrés Lorente and Don José María Teuchaud, judge and secretary of the municipal court; that of Don José María Sánchez, curé of the parish of Alumbres, with residence in this town; and that of Don Raphael Charques and other inhabitants, who confirm the facts set forth by Don Pasqual Molina, and I consider them authentic. La Union, 12th of Nov., 1885. Antonio Miralles. (There is a sign.)

Don Ricardo Montes Helguero, president judge of La Union and its judicial district, attests the sign, signature, and seal of the above-mentioned notary of this town, Antonio Miralles. La Union, 12th of Nov., 1885. Vº. Bº Ricardo Montes. (There is a seal of the court.) (Seal of authentication.)

#### LIRIA.

Don Marcos Cotanda y Oliver, advocate and municipal judge of the town of Liria, certifies:

That, having examined the death register of this municipal court, it appears that from the 23rd of June last to the 25th inst. there were registered 371 deaths from the reigning epidemic of Asiatic cholera; in witness whereof, at the instance of Don Francisco Jiménez María, I have given the present certificate at Liria 29th of August, 1885. (Signed and sealed.) Marcos Cotanda. (There is a seal of the municipal court.) José Escrig, secretary.

Don Eduardo Daud Solano, Don Modesto Gantó Aragón, Don Miguel María Alamá Torrijo, Don Ignacio Guillém Roig, and Don Antonio Artiga Aleixandre, physicians of the town of Liria, the four first officials of whom Guillém is the subdelegate, certify:

That, from the daily medical returns to this municipality and from the registers of inoculations by the prophylactic system of Dr. Ferrán, it appears:

1st. That the cholera epidemic began in this town the 23d of last June.

2d. That 1,419 inhabitants submitted to the system of prophylactic inoculations of Dr. Ferrán, of whom 125 laborers and 434 poor people were inoculated gratuitously.

3d. That the inoculations occurred at the dates and in the manner following:

Inoculated in Valencia from the 23rd of June to the 2nd of July, about three hundred.

Inoculated in this town on the 3rd and 4th of July, 1,119.

There were reinoculated in the same town, of the first 300 inoculations, 150 people.

4th. That the course of the epidemic was from the 23rd of June to the 25th of the current month, as follows:

Official census, 9,460 inhabitants. From the 23rd of June to the 9th of July, inclusive, there were 162 attacks and 79 deaths among the non-inoculated; and 16 attacks and 4 deaths among the inoculated, within the first five days after inoculation, whilst there were no attacks and no deaths after the first five days, and no attacks and no deaths among the re-inoculated.

From the 10th of July to the 25th of August, inclusive, there were 399 attacks and 275 deaths among the non-inoculated; 24 attacks and 3 deaths among the inoculated; no attacks or deaths among the re-inoculated.

*Observations.*—1st. That of the 6 deaths occurring among the inoculated 4 were within the fifth day.

2d. That the attacks within the fifth day were 16 in number, and the most of the at-



tacked already had diarrhœa; those who were attacked after the fifth day, 24 in number, had lighter attacks.

3d. Of the hundred and fifty re-inoculated, not one had the slightest inconvenience, notwithstanding that many of them, as well as those once inoculated, had been in contact with cholera patients, such as the clergymen, physicians, and notaries.

4th. We call attention to the following cases:

Carmelo Terranegra Viu, his whole family being inoculated, except his cousin Matías Estevéz, saw the latter die.

Genoveva Feltrer, who inoculated, with his daughter, saw his wife die, Mariano Martínez, who was inoculated.

Leonor and Pascuala Navarro Heredia, both inoculated, lost their mother and brother, who were unwilling to submit to the operation.

José Antonio Marqués Martínez had his whole family inoculated, except a little girl, who died.

Dr. Francisco Garríquez Falomir, who did not submit to the inoculation, died, whilst in the rest of his family, who were inoculated, there was nothing unusual happened.

Don Felix Garríquez, brother of the former, lost a daughter, the sole person in the family who was not inoculated.

Liria, 26th August, 1885. Eduardo Daud. Miguel María Alamá. Antonio Artiga. Ignacio Guillem Roig. Modesto Cantó.

Don Salvadore Lapiedra Navarro, mayor of this town of Liria, certify :

That the figures and other matter expressed in this document are in conformity with the register and the data in this municipality, in witness whereof I have given these presents, which I sign at Liria, 26th August, 1885. Salvador Lapiedra. (Seal of the municipality.)

The undersigned notary of the illustrious college of the district of the court of Valencia, inhabitant of the town of Liria, testify :

That I know these signatures and seals appearing in the foregoing document, to wit: Of Don Marcos Cotanda, municipal judge of this town; of Don José Eserig, secretary of the same; of Don Eduardo Daud Solano, Don Modesto Cantó y Aragón, Don Miguel María Alamá Torrijo, Don Ignacio Guillém y Roig, and Don Antonio Artiga y Aleixandre, physicians, and of Don Salvador Lapiedra, mayor of this town, and I consider authentic the said signatures and seals. Liria, 29th of August, 1885. (There is a sign.) Francisco de Paula Ramírez.

The undersigned, notaries of the illustrious college of Valencia, notarial district of Liria, attest the signs, signatures, and seals of our colleagues in this town, the notary Don Francisco de Paula Ramírez y Bonet. Liria, 29th of August, 1885. (There is a sign.) Juan J. Porcar. (There is a sign.) Francisco Jiménez Marín. (There is a seal of attestation.)

The undersigned licenciates in medicine and surgery, residence in this town of Liria, certify :

That among the numerous inoculations and re-inoculations against cholera by the method of Dr. Ferrán, practiced in this town, the number of which was upwards of 1,400 of the former and 150 of the latter, we were unable to observe any local or general disturbances which would prejudice in the least the health of the inoculated, except in Guana Vela Muedra, 35 years of age, servant, who in consequence of the inoculation had a circumscribed phlegmon in each arm at the point of inoculation, which terminated by suppuration in ten days without further consequences. And in order to confirm the foregoing, with the object of enabling an opinion as exact as possible to be formed concerning the harmlessness of the said prophylactic method against cholera, we give and sign these presents in Liria, the 15th of October, 1885. (Signed and sealed.) Ignacio Guillém Roig, subdelegate. Eduardo Daud. Modesto Cantó. Miguel María Alamá.

*Attestation.*—Don Francisco Jiménez y Marín, notary of the illustrious college of the district of Valencia, inhabitant of this town, witness: That I know the signature and seal of Senores Ignacio Guillém y Roig, Eduardo Daud, Modesto Cantó, and Miguel María Alamá, licenciates in medicine and surgery, by whom it appears the foregoing certificate was given, and I consider them authentic. Liria, 22nd of October, 1885. (There is a sign.) Signed and sealed. Francisco Jiménez Marín.

*Attestation.*—The undersigned notaries of the illustrious college of Valencia, notarial district of Liria, attest the sign, signature and seal of the notary Francisco Jiménez. Liria, 22nd October, 1885. (There are two signs.) Signed and sealed. Francisco de Paula Ramírez. Juan J. Porcar. (There is a seal of attestation.)

## LINARES.

The undersigned physicians practicing in this city certify :

That the course of the cholera epidemic in this town and the results of preventive inoculations have been as follows:

From the 11th of August to the 13th of October, inclusive, there were 225 attacks, 112 deaths among the non-inoculated; during the same period there were no attacks and no deaths among the inoculated within the first five days after the inoculation, and there was one attack and no death among them after the first five days, whilst there was neither attack nor death among the re-inoculated; the official census is 36,526.

The physicians who performed the inoculations, J. Aballán. Dr. Antonio M. Ruíz. J. Las-Marías.

In accord with the data in this municipality. Linares, 1st November, 1885. The mayor pro tempore, Francisco Bautista. The secretary, Manuel Trillo. (Seal of the municipality.)

In conformity with the data existing in this municipal court. Linares, 26th November, 1885. The municipal judge, Policarpo Román. The secretary, Jerónimo Ortega.

Don Nicolás López y Mizzi, notary of the territorial College of Granada and of this district, with residence in this city, give faith and testimony : That the signatures affixed by the physicians Don José Abbellán, Don Antonio María Ruíz, and Don Joaquín Las-Masías, as also those of the mayor, Don Francisco Bautista, and secretary of the municipality, Don Manuel Trillo, as also that of the municipal judge, Policarpo Roman, and the secretary of the court, Don Jerónimo Ortega, in the foregoing certificate are the same as usual and appear to be from their own hands, all being in the exercise of their respective charges. And at the instance of the parties interested I give these presents, which I sign and seal at Linares, the 29th of November, 1885. Nicolás López, notary.

*Attestation.*—The undersigned, notaries of the College of Granada, inhabitants and residents of this city, attest the sign, signature, and seal as above of our colleague Don Nicolás López Mizzi, Linares, 30 of November, 1885. (There is a sign.) Juan de la Cruz Huete. (There is a sign.) Juan Manuel de Martos. (There is a seal of attestation.)

## MASANASA.

Don José Ramón Calvo y Pelarda, notary of this illustrious college, and inhabitant, give faith and testimony that Don Fernando Angla y García, inhabitant of Valencia, has exhibited to me a document, of which the following is a literal copy:

The undersigned, physicians residing and practicing in Masanasa, province of Valencia, certify:

1st. That this town was invaded by Asiatic cholera, the first case appearing on the 5th of last May; and from that date to the 17th of said month there were 8 attacks and 5 deaths.

2nd. That the 17th of said month of May we began to practice the prophylactic inoculations of Dr. Ferrán, to the number 177, which number was slowly added to up to the 30th of June, when it reached 418.

3rd. That during this period, from the 17th of May to the 30th of June, both inclusive, there occurred 92 attacks and 42 deaths by cholera, there being 3 of the former and 2 of the latter in persons inoculated, all of these being within 5 days following the inoculation.

4th. That in view of the terrible development of the epidemic during the latter days the town council and the population *en masse* resolved that greater impulse be given to the anti-choleraic inoculations of Dr. Ferrán. There were performed on the 29th and 30th of June 1,555 inoculations, which with those previously performed constituted a total of 1,973, leaving at the



said date of 30th of July, the population classified in the following manner (The census was 2,596):

Inoculated .....	1,973
Non-inoculated .....	576
Decreased by death .....	47
Total .....	2,596

5th. That during the period of 5 days after the inoculation upon this grand scale, that is to say, from the 1st to the 5th of July, both inclusive, there were 37 attacks and 28 deaths, of which 25 attacks and 13 deaths occurred in inoculated persons and 12 attacks and 15 deaths in the non-inoculated.

6th. That from the 6th of July to the 17th of August, both inclusive, there occurred among the 576 non-inoculated 35 attacks and 24 deaths; among the 1,973 inoculated, 11 attacks and 6 deaths.

7th. That in consequence of an official order, which directed that only Dr. Ferrán personally should practice the inoculations, it was impossible to perform the re-inoculations which should complete the prophylaxis according to the system of Dr. Ferrán.

For the authentication of the foregoing we sign these presents at Masanasa, the 17th day of August, 1885. The official physician, José Llorca. Christóbal Sánchis.

The undersigned, mayor of Masanasa, witnesseth: That the official census of the population of this town is 2,596 souls, and that the number of attacks and deaths as expressed in the above certificate is in conformity with the health records of this municipality. Masanasa, 17 August, 1885. The mayor, Pasqual Nácher. (Seal of the municipality.)

The municipal judge who subscribes, in charge of the civil registry of the town of Masanasa, certifies: That the deaths which are enumerated in the preceding certificate are in entire conformity as well with respect to the number as to the dates with the entries in the register in my charge. Masanasa, 18th August, 1885. J. Bautista Brú. (Seal of the court.)

The undersigned parochial curé of Masanasa, certifies: That the dates of deaths, certified by the physicians, Don José Llorca and Don Christóbal Sánchis, are in conformity with the parochial record of burials. Masanasa, 17th August, 1885. The parochial curé, Ricardo Morte. (Seal of the parish.)

The foregoing concords with the exhibited document, which, signed, I again return to the interested parties. In witness whereof I mark and sign upon a folio, 10th class, number 529,274, making a note in the index book in Valencia, 22nd August, 1885. José Ramón Calvo. (There is a sign.)

#### MONTAVERNER.

Don Francisco Raga y Millá and Don Federico Vañó y Ortiz, physicians of the town of Montaverner, certify:

1st. That the epidemic of Asiatic cholera appeared in this town the 20th of June and terminated the 24th of August.

2nd. That from the 20th of June to the 8th of July there were 54 attacks and 13 deaths.

3rd. That on the 9th of July there were inoculated by the system of Ferrán 137 inhabitants of this town above 7 years of age, and the majority of them poor laborers, without any of them suffering, as a consequence of this operation, any local trouble worthy of mention; and on the 12th of August, 93 of the inoculated submitted to reinoculation, with similar freedom from accidents.

4th. From the 9th of July the course of the epidemic was as follows: 28 attacks and 6 deaths among the non-inoculated; and 1 attack within the first 5 days and 1 on the 30th of July among the inoculated, both followed by good and prompt convalescence.

5th. That the census of this town is 906 souls, and according to the municipal registry 548 are upwards of 7 years of age; it being, according to our judgment, necessary to take this figure (for there occurred no attack in any individual under 7 years of age) in order to draw conclusions from reliable data.

6th. That in spite of the fact that in some families not all of those inhabiting the same house were inoculated, those non-inoculated did not experience the slightest indisposition.

In witness whereof we sign these presents at Montaverner the 11th of October, 1885. Francisco Raga. Federico Vañó.

The present certificate examined, and found in conformity with the records of the municipal secretariat. Montaverner, 10th October, 1885. Vº. Bº., the mayor, Pasqual Tormo. The secretary, Pedro Alcaide. (Seal of the municipality.)

Examined, and in conformity with the records of this municipal court. Montaverner, 11th October, 1885. The municipal judge, Jamie Vañó. (Seal of the municipal court.)

Examined, and in conformity with the data contained in the parochial books in my possession. Montaverner, 13th October, 1885. J. Isidore Juan, curé. (Seal of the parish.)

The undersigned, notary of the college of the territory of Valencia, in the district of Albaida, to which appertains the village of Montaverner, witnesseth: That I know the signatures of Don Francisco Raga, of Don Federico Vañó, physicians resident in this town; of Don Pasqual Tormo and Don Pedro Alcaide, mayor and secretary of the same; of Don Jamie Vañó, municipal judge of the said town, and of Don Juan Isidro Juan, parochial curé of the same; and I consider authentic that which appears connected with their respective names in the foregoing certificate, as also the seals, those of the municipality and municipal court, and the church above mentioned. And, at the instance of the interested party, I give these presents, sealed and signed at Albaida the 14th October, 1885. (There is a sign.) Eduardo Lassala y Mercader.

#### ONDARA.

The undersigned, Don Vicente Miralles Barber and Don Enrique Grustáu Perelló, official physicians practicing in this town of Ondara, certify:

1st. That this town is surrounded by the villages Denia, Benidoleig, Teulada, Sagra, Ráfol, and Pego; the 1st being distant 7 kilometres; the 2nd, 10; the 3rd and 4th, 5; the 5th, 7; and the 6th, 8; all of them invaded by Asiatic cholera. A sanitary cordon was established, which interrupted communication between the said town and other villages mentioned above.

2nd. That as it was the determination of the Government that, among the experiments of an official character which should be performed concerning the prophylactic inoculations of Dr. Ferrán, there should be inoculations practiced in a village not yet infected but surrounded by other villages in which the epidemic raged, the population of Ondara, among whom there existed 275 inoculated persons on the 8th of July last passed, who had already witnessed to some extent the harmlessness of the anti-choleraic operations, and had tested also, in certain measure, the preventative action of the same, offered themselves as the subjects of the official experimentation above mentioned.

3rd. That, the offer being accepted, Dr. Ferrán and the official commission, composed of Drs. Florencio Castro, Sanz Bombin and González de Segovia, and the section of statistics, presented themselves in the above mentioned town of Ondara; the first named and his assistants, Drs. Gimeno, Candela, Murga, Moreno, Plá and Aranda, performed 1,205 inoculations on the 9th and 10th of August last.

4th. That at once the sanitary cordon was removed and communication between the inhabitants of Ondara and those of the surrounding villages, in which as already mentioned the epidemic raged, was re-established, the inhabitants being engaged in the cultivation of grapes for conversion into raisins—a fruit which constitutes the principal wealth of the region.

5th. That in spite of the continuous intercommunication following the raising of the cordon and the agricultural operations re-established between the inhabitants of Ondara and those of the neighboring villages, there has not been up to date any attack of cholera among the inhabitants of Ondara.

6th. That on the 15th day of August there arrived in this village an inhabitant, Francisco Marí Martí, proceeding from Madrid, where he had been working in the tile-works of Varela. In 36 hours from his arrival this man presented the symptoms which characterize Asiatic cholera; he was visited by a member of the official commission, Dr. González de Segovia, and was well on the 21st of the same month.



7th. That this case was entirely isolated and did not constitute a focus, for up to date no other attack has been registered.

In testimony whereof we give these presents, which we sign at Ondara the 7th of September, 1885. Vicente Miralles. Enrique Grustáu.

Don L. José Bosch Oliver, mayor of this town of Ondara, certify: That the official census of this town is 3,093 inhabitants, and that which is expressed in the foregoing certificate is in conformity with the sanitary records of this municipality. Ondara, 7th of Sept., 1885. The mayor, L. José Bosch. (Seal of the municipality.)

Don Vicente Giner Gadea, municipal judge of this town of Ondara, certify: That the entries of death in this civil registry having been examined, there appeared to have occurred in this town since the 8th of last August up to to-day only six deaths; none of them being occasioned by Asiatic cholera. In witness whereof I sign these presents at Ondara, the 7th of Sept., 1885. Vicente Giner. (Seal of the municipal court.)

The undersigned, parochial curé of Ondara, certifies: That from the entries on the book of interments of this town, it appears that from the 8th of last Aug. up to to-day there were given sepulture in the cemetery of this town six corpses. Ondara, 7th of Sept., 1885. The parochial curé, Dr. Salvador Verdós. (Seal of the parish.)

Don Blas Frasset, notary of the illustrious provincial college of Valencia, with residence in the town of Ondara, witnesseth: That I know the signatures and seals of the foregoing Don Vicente Miralles, Don Enrique Grustau, physicians; Don José Bosch, mayor; Don Vicente Giner, municipal judge; Dr. Salvador Verdós, parochial curé; inhabitants of this town of Ondara, and I consider them authentic. In witness whereof I give these presents, which I seal and sign at Ondara, 7th of Sept., 1885. (There is a sign.) Blasfrasset.

#### PUEBLA DE RUGAT.

Don Francisco Climent Pons and Don Eduardo Vercher y Mongrell, physicians, the first official of this town of Puebla de Rugat, and both residing and practicing in the same, certify:

That in this town, whose official census is 1,800 inhabitants, the choleraic epidemic began on the 24th of June of the present year with great intensity, since from this date to the 7th of July there occurred 130 attacks and 78 deaths; a panic among the inhabitants grew to such an extent that two-thirds of them went out to the houses in the fields, leaving, on the above-mentioned date of 7th of July, in the town only about 700 inhabitants. At the said date 216 were subjected to the anti-choleraic inoculations against cholera, the method of Dr. Ferrán; among these not the slightest disturbance, either local or general, occurred. From this date to the 20th of July, the day upon which the epidemic terminated, there were 40 attacks, of which 39 were among the non-inoculated; only one inoculated person was attacked and he was seized on the third day after the inoculation, but he made a prompt recovery. Among the 39 attacked there were 12 deaths; not one of the inhabitants who abandoned the town was attacked.

In witness whereof we sign these presents at Puebla de Rugat, the 15th of Oct., 1885. Francisco Climent. Eduardo Vercher.

The facts set forth in the preceding certificate are found in conformity with those of record in this municipality. Puebla de Rugat, 15th of Oct., 1885. The mayor, Honario Jornet. (Seal of the municipality.) D. S. O., Pasqual Alonso, secretary.

Examined and found in conformity with the records of this municipal court. Puebla de Rugat, 15th of Oct., 1885. (Seal of the municipal court.) José Gomar.

Examined, and found in conformity with the sacramental books of the archives in my charge. In testimony whereof I sign and seal with this parochial seal. Puebla del Dugue or Rugat, 15th Oct., 1885. (Seal of the parish.) Vicente Gabriel Climent, Curé.

I, the undersigned, notary of the illustrious college of the territory of Valencia, in the district of Albaida, to which appertains the village of Puebla de Rugat, give faith: That I know the signatures of Francisco Climent and Don Vercher, physicians residing in this town of Puebla de Rugat; of Don Honario Jornet and Don Pasqual Alonso, mayor and secretary

of the same town; of Don José Gomar, municipal judge of the said town, and of Don Vicente Gabriel Climent, curé of the parochial church of the said town, and I consider authentic the foregoing certificate, as also the signatures and seals of the municipality and municipal court and parochial church of the said town.

In witness whereof, at the instance of the party interested, I give these presents, which I sign and sign at Castellón de Rugat, 15th of Oct., 1885. (There is a sign.) Eduardo Todo y Soler.

## SALSADILLA.

The undersigned licentiate in medicine and surgery, resident in this town, certifies:

That in this town, whose population, according to the last census of the year 1877, is 1,498 inhabitants, there were inoculated on the 27th of August by the method of Dr. Ferrán 1,057; of these 446 were re-inoculated on the 7th and 8th days of Sept., without there being produced in the inoculated other illness or complication than two simple phlegmons, one in a child of six years, due to scratching, and the other in a married adult, who too soon went to work in the fields. Both of these phlegmons terminated in recovery within fifteen days. This town has not been invaded by cholera, in spite of being surrounded by infected villages, and in spite of the sanitary cordon having been immediately removed after the inoculations were practiced. In testimony whereof I give these presents at Salsadella the 15th of Oct., 1885. (Signed and sealed.) Hermelio Miralles.

The undersigned, notary of the College of Valencia, with residence in the town of San Matéo, certify: That I consider authentic the signature and seal of the above Don Hermelio Miralles, physician of Salsadella.

In witness whereof I give these presents, which I sign and seal at San Mateo, the 18th of Oct., 1885. (There is a sign.) Rafael Peñalva.

## SANTAPOLA.

Don Antonio Erades Más, licentiate in medicine and surgery, and official physician of this town, certifies:

That from the date upon which the practice of the anti-choleraic inoculations of Dr. Ferrán began in this town up to the end of the epidemic there occurred 42 attacks and 22 deaths, all of these among the non-inoculated, except one, who died upon the third day after the inoculation. (The number of inoculated was 622.) All these individuals were living within the town limits.

In witness whereof I give these presents, at Santapola, the 29th of Sept., 1885. (Signed.) Antonio Erades. V°. B°. Vicente Salinas, (There is a seal with the following words: "Constitutional municipality of Santapola.")

Don Vicente Salinas Galiana, mayor of this town of Santapola, certifies: That on account of the majority of inhabitants having absented themselves from this town from fear of invasion by cholera, there was made this day an enumeration of those who remained within the town, as also of those located in the buildings along the sea shore near the town, with the result of finding two hundred inhabitants. And in order that Dr. Ferrán may be able to establish the truth of the foregoing, at his instance I give these presents, at Santapola, the 15th of Aug., 1885. Vicente Salinas (Seal of the municipality.)

## VILLANUEVA DE CASTELLÓN.

The undersigned physicians, residing and practicing in this town of the province of Valencia, certify:

1st. That the 29th of last March the first attack of Asiatic cholera occurred in this town, the last being registered on the 24th of July of this year.

2nd. In this long period of time there were 194 attacks, as the municipal registry shows, and 80 deaths recorded in the archives of the court.



3d. At different dates after the 15th of May 192 persons belonging to this town were inoculated in the cities of Valencia and Alcira.

4th. The 6th day of July there were inoculated in this town by Dr. Navarro Gil, a delegate of Señor Ferrán, 138 poor people and 115 of the opulent, without any of them having suffered any local trouble which required medical assistance.

5th. The 192 inoculated in Valencia and Alcira were re-inoculated, but the rest could not be re-inoculated on account of the prohibition of the government against the procedure of Dr. Ferrán.

6th. The foregoing data may be arranged as follows:

Official census of the population.....	3,127
Attacks .....	194
Deaths .....	80
Census of the inoculated.....	445
Attacks among the inoculated.....	1
Attacks among the re-inoculated.....	0
Deaths .....	0

NOTE.—The attack of the inoculated person was on the third day after the operation was performed.

As a notable occurrence in the family of Don Pasquel Benetó Caldés, proprietor and inhabitant of Mayor st., No. 40, deserves to be mentioned. His whole family, except his wife, Doña Elisa Martínez Ferrando, was inoculated; only the latter was attacked with cholera and died from the said disease.

In witness whereof we sign these presents, at Villanueva de Castellón, the 10th of Oct., 1885, José Pérez. Dr. Víctor Mancho.

Examined and found in conformity with the records of this municipality. Villanueva de Castellón, the 10th of Oct., 1885. The mayor, Eusebio Franco. (Seal of the municipality.)

Examined and found in conformity with the registers of this court. Villanueva de Castellón, 11th of Oct., 1885. The municipal judge, Silverio Llagaria. (Seal of the municipal court.)

Examined and found in conformity with the death registers preserved in the archives of this parish. Villanueva de Castellón, 12th of Oct., 1885. Antonio Carrasco, curé. (Seal of the parish.)

I testify that I know the signatures of Don José Pérez and Dr. Víctor Mancho, physicians residing and practicing in this town; of Don Eusebio Franco, first lieutenant mayor of the same; of San Silverio Llagaria, who is municipal judge, and of Don Antonio Carrasco, curé of this parish, and I consider them authentic. I, the undersigned, notary of the illustrious college of Valencia, district of Alberique, with residence in Villanueva de Castellon, the 12th of October, 1885. (There is a sign.) Antonio Bataller. (There is a seal.)

## ANALYSIS OF FERRÁN'S INOCULATIONS IN RELATION TO PROPHYLAXIS.

Names of villages in which inoculation was performed.	Population present and not inoculated.*	Attacks of non-inoculated.	Attacks of non-inoculated per 1,000.	Deaths of non-inoculated.	Deaths of non-inoculated per 1,000.	Percentage of mortality of cases.	Number inoculated.	Attacks of inoculated.	Attacks per 1,000 of inoculated.	Deaths of inoculated.	Deaths per 1,000 of inoculated.	Percentage of mortality of inoculated cases.
Adzaneta.....	680	30	44.11	26	29.11	.66						
Albaida.....	2,620	205	78.24	84	32.06	.41	670	15	22.38	3	4.47	.20
Alberique.....	3,808	235	61.71	97	25.47	.41	1,188	16	13.46	2	1.67	.12
Alcalá de Chisvert.....	5,804	2,500	430.77	698	118.71	.27	298	3	10.1			
Alcira.....	4,950	404	81.60	206	41.67	.51	11,050	99	8.05	24	2.17	.24
Algemesi.....	6,654	554	83.24	203	30.5	.36	1,202	32	26.62	8	6.65	.25
Alginet.....	2,721	290	106.57	100	36.78	.34	720	14	16.09	3	3.44	.21
Bélgida.....	569	27	46.8	14	24.5	.51	580	6	10.34	2	3.45	
Benifayó.....	715	283	397.2	186	260.1	.66	2,717	23	8.46	5	2.20	.26
Bellreguart.....	1,990	15	7.58	5	2.5	.33	312	1	3.2	1	3.20	1
Castellón de la Plana.....	27,352	519	20	300	17.75	.57	648	2	3.08			
Catarroja.....	4,202	311	74	222	52.83	.71	1,319	60	45.48	5	19	.41
Cervera.....	1,650	143	86.66	72	43.63	.50	530	2	3.79			
Cheste.....	2,091	141	67.43	100	47.82	.70	3,136	13	4.14	7	2.23	.54
Chiva.....	3,078	140	45.48	54	17.54	.38	1,308	11	8.4	5	3.82	.45
La Eliana.....	500	14	30.95	5	11.13	.35	51	1	19.6			
La Union.....	21,438	1,075	50.14	509	23.74	.47	572	6	10.49			
Liria.....	8,041	561	69.76	354	44.02	.63	1,419	40	28.18	7	4.93	.17
Masanasa.....	623	144	231.13	84	134.83	.58	1,973	39	19.81	11	5.57	.28
Montaverner.....	769	82	106.63	18	23.4	.22	137	2	14.59			
Puebla de Rugat.....	1,584	209	131.94	102	64.33	.48	216	1	4.63			
Villa Nueva de Castellón...	2,722	194	72.33	80	29.82	.41	445	1	2.24			
Totals.....	104,561	8,046	76.25	3,512	33.58	.43	30,491	387	12.69	104	3.41	.26

\* Many frequently fled.

*Comparison of liability of attack and death among the inoculated and the non-inoculated.*

Liability of non-inoculated to attacks of cholera greater than that of the inoculated.....	6.06 times.
Liability of non-inoculated to death from cholera greater than that of the inoculated.....	9.84 times.

NOTE.—These tables comprise the results of single inoculations only. According to the statistics second inoculations seem to have been followed by far fewer attacks and scarcely any deaths, but their apparent protective value is not shown by these tables.

It should be noted also that no attempt has been made to exclude from the number of attacks and deaths among the inoculated those occurring before the protective action (if there be any) of the inoculation has had time to assert itself.

Illustration No. 38 graphically presents the results of the foregoing analysis of the Ferrán inoculations. These charts indicate—

First. The average percentage of attacks and deaths in the towns of the province of Valencia which were invaded by cholera, as obtained from the official Government report; it shows that the attacks per thousand of the population numbered 62.33, and that the deaths per thousand were 31.11.

Second. The relative frequency of attacks and deaths in the inoculated and non-inoculated of those towns where inoculation had been performed; it is constructed from official statistics of the anti-choleraic inoculations of Ferrán, and shows that in these towns the attacks among the non-inoculated numbered 76.95 per thousand and the deaths among the non-inoculated 33.58 per thousand, whilst among the inoculated the attacks were 12.69 per thousand, and the deaths were 3.41 per thousand.

Third. The relative immunity from attack and death by cholera of the inoculated and non-inoculated population, as deduced from the official statistics of the anti-choleraic inoculations of Ferrán. This portion of the chart shows that among the inoculated inhabitants im-

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munity from an attack of cholera was 6.06 times greater than among the non-inoculated, and that immunity from death by cholera was 9.84 times greater among the inoculated than among the non-inoculated.

In view of all the foregoing data relative to the anti-choleraic inoculations of Ferrán, it seems to me that there is no slight ground for the belief that subcutaneous inoculations into man of pure liquid cultures of the comma bacillus of Koch, whilst they do not usually excite disturbances which in any way resemble Asiatic cholera, apparently exercise a certain protective influence through the establishment of a considerable degree of immunity from attack and death by cholera. The secondary claim of Ferrán that the anti-choleraic inoculations constitute a means of protection of communities from serious invasions of cholera as well as a means of rapidly terminating a local epidemic already raging without recourse to the universally hated measures restricting personal liberty, or to the imposition of damaging restraints upon trade and commercial intercourse, has in its support the same amount and class of testimony. If the one shall become established, the other must then be admitted as a logical consequence. The efficiency of such a mode of prevention once established, the ideal means of combatting cholera would become at once the most practical. It is just those localities or countries, where filth and ignorance abound, that cholera universally and naturally selects for its greatest depredations; it is precisely those also where defense by radical hygienic improvements is hopeless; and it is also those wherein during times of popular panic such a harmless and in every way apparently uninjurious measure of prophylaxis would be most willingly and widely submitted to.

Furthermore, these Spanish inoculations of cultures of the comma bacillus of Koch into tens of thousands of human beings may be regarded in some measure as the complement of laboratory experiments upon the lower animals with the same microbe. Although the latter are infinitely less numerous, they are far more exact than the former. Nevertheless, scattered through the mass of evidence relating to the Spanish inoculations which I have incorporated in this report there is quite an amount of close observation of the effects of these inoculations in man. Whilst few of these related effects present striking resemblance to an active attack of Asiatic cholera, yet occasionally the resemblance has been noted. In this connection it must be remembered that the dose in the case of man was relatively very small. On the whole, I think that the evidence relative to the human inoculations against cholera, after the method of Ferrán, constitutes a valuable although not an absolutely conclusive supplement to and confirmation of the claim of Koch that his comma bacillus is the specific active cause of Asiatic cholera.

Attacks,  
62.33 per 1000.

Deaths, 31.11 per 1000.

2d. Relative frequency of attacks and deaths in the inoculated and non-inoculated in those towns where inoculation has been performed.

*Deduced from official statistics of the Anticholeric inoculations of Ferran*

Attacks, non-inoculated,  
76.95 per 1000.

Deaths, non-inoculated, 33.58 per 1000.

Attacks, inoculated. 12.69 per 1000.

Deaths, inoculated, 3.41 per 1000.

*Deduced from the official statistics of the Anticholeric inoculations of Ferran.*

Immunity from attacks among the inoculated is 6.06 greater.

6.06

Immunity from attacks among the non-inoculated being 1.  
Immunity from deaths among the non-inoculated being 1.

$$= 9.84$$

Immunity from deaths among the inoculated is 9.84 greater.





## CHAPTER VII.

### MEASURES OF PREVENTION, GENERAL AND INDIVIDUAL.

#### SECTION 1.

##### MARITIME QUARANTINE DISCUSSED.

In this country active consideration by legislators of the dangers which threaten the general welfare by the invasion of epidemic diseases through our foreign communications has in the past been fitful in the extreme.\* From 1698 down to the present moment it has been only when, goaded by the spur of imminent danger or lashed into activity by the fresh memories of disastrous visitations, the people have with a great unanimity urgently and loudly demanded it, that spasmodic efforts to protect the general health have found a reflex in the statute laws. Whilst our statesmen and law-makers have with more or less wisdom and constancy by the enactment of national and local laws guarded the personal liberties and material interests of the citizen; have established more or less adequate regulations for internal trade and foreign commerce; and have performed the public duty of providing defenses against a common enemy, yet thus far they have with singular neglect failed of their own motion to make any attempt to provide against the ever-present danger to the general welfare from the ravages of those epidemic diseases which are brought to our shores from foreign lands. It is, however, true that the Government has in recent years attempted to prevent the importation of diseases to which cattle are subject by the appointment of inspectors to act in harmony with the officials of such States as have established a quarantine against diseased animals.

The health laws under which we at present live are, as a rule, such only as emergencies have called into existence. Though many of their provisions may have endured beyond the danger which immediately threatened, they have been framed with an eye single to the then present need, and with the expectation that an alarmed public sentiment in the threatened locality would materially supplement their incompleteness. They have seldom or never been drafted with a full recognition of the need of adequate and constant protection of the health of the general public. Imperfect and temporizing as the local health laws have been and still are, the spirit which has inspired them has naturally felt the promptings of local interests only, and their inefficient provisions, as a matter of course, have limited their meed of protection, more or less selfishly, to the local interests involved. Moreover, the commercial interests of rival ports, the partisan struggles of opposing political factions, and the heedless parsimony with which money has been doled out for the execution of such health laws as exist have rendered their vigorous and fearless administration well nigh impossible.

We are aware that there are among distinguished sanitarians, even in this country, those who more than question the power of any quarantine regulations which could be devised, however intelligently and thoroughly enforced, to protect efficiently the general public against

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\* Much of the matter in this chapter has already appeared in "An Address upon National Control of Maritime Quarantine" issued by a committee of the College of Physicians of Philadelphia, 1888; but, since it was prepared by the writer and adopted by the committee of which he was a member, no effort will be made to distinguish the one from the other.



foreign invasions of contagious and infectious diseases, and who are inclined to advocate the policy that the State should rather expend her energies and money in removing local conditions which favor the development of epidemics and make their spread possible. But the only country where such a policy has been pursued with some measure of success is England, *after a decade of expenditure of thirty millions of dollars per annum* (exclusive of and in addition to large expenditures made by the General Government, for this large sum has been expended by local boards) *within her compact, small territory, located as it is out of the line of movement of the hordes of infecting emigrants constantly leaving all parts of Europe and outside of the latitudes which favor the existence of yellow fever.* After the United States of America shall have intelligently spent at least an equal sum, namely, *three hundred millions of dollars*, in the earnest and persistent effort to improve the hygienic surroundings of the homes of a population already nearly *twice as great as that of England, and scattered over a territory thirty-four times as extensive*, we may then have reached a condition with regard to public health in which it may possibly (?) be wise to abandon maritime quarantine and to rely mainly upon the protection secured by a perfected local hygiene alone. Meanwhile, under present circumstances, recognizing the enormous cost of radically destroying the local conditions which foster the development and prevalence of epidemics by thoroughly removing the filth among which they thrive, and fully appreciating the incalculable economic benefit which would certainly follow such a wise expenditure of hundreds of millions of the public money, we feel convinced that, with respect to the danger which constantly threatens the public health from abroad, there are at this time only two courses between which we in this country are to choose, namely: a practical abandonment of the general public to a more or less individual and fruitless struggle with the agents of contagion and infection in whatever localities the movements of immigrants may chance to convey them; or an intelligent, constant, earnest, and vigorous effort to stop and destroy them at the ports of entry. Whilst it is true that to remove the local conditions which favor the development and spread of contagious and infectious diseases is to lessen greatly their harmfulness, it is none the less undeniable that to destroy the infecting agent or contagium or to prevent its entrance into the country is, by a single act, to prevent the implantation of the seed and to render the harvest impossible, *let the soil be never so fertile.* Furthermore, the cost of preparing to wage a successful combat against the entrance and spread of disease among thousands of scattered villages, towns, and cities is infinitely greater than that which would be required to place our ports in a nearly perfect state of defense against those diseases which are now subjected to quarantine.

As an example of what it costs and of the time required to radically improve the hygienic condition of a single dirty city, I would point to what has recently been determined upon with regard to the city of Naples, which suffered so severely from cholera in the epidemic of 1884, namely, the demolition of seventeen thousand houses and sixty-two churches in the very heart of the city; it means the expenditure of over \$40,000,000 in a single sanitary work which will take ten years to complete.

The information contained in Chapter I concerning the widespread, miserable hygienic conditions of the villages, towns, and cities of Egypt, France, Italy, and Spain shows conclusively the utter futility, at least for decades to come, of any hope of preventing the introduction, spread, and ravages among them of such a disease as cholera by purely local hygienic measures. In order to place any one of these countries in such a good hygienic condition that it would be impossible for the germs of Asiatic cholera to find a favorable place of development, hundreds of millions of money must first be expended in sanitary improvements, and even if this were seriously undertaken decades would necessarily pass before purely hygienic measures could be relied upon as safeguards. Yet even now, unmindful of the high annual mortality from preventable diseases in all of those countries and of the recent devastations they have experienced from cholera, there is no indication that any one of them has determined to commence on a universal scale, serious attempts to place the whole country in radically improved sanitary conditions. In fact, in their present financial condition the raising of the vast sums required would be simply impossible.

But the loss to the public occasioned by a single widespread epidemic of cholera, yellow

fever, or small-pox is far greater than would be the cost of the proper maintenance for many years of a perfect quarantine establishment at all of our ports.

The hundreds of thousands of European immigrants who annually reach our country after starting from or passing through localities which are infected with contagious diseases, frequently in their persons or in their pestiferous clothing and effects, carry with them, often as far as their ultimate destination and to let loose there, the active germs of these diseases; and the herding of these immigrants into the miserably ventilated and frightfully unsanitary quarters usually provided for the steerage passengers on Atlantic steam-ships, the modern rapidity of ocean travel, and the great facility with which these swarms of people are soon distributed all over our country, combine to multiply the danger to the public health with which, under the laxity of our laws and the unsatisfactory administration of them, this incessant influx constantly menaces the country.

In their enormous numbers, their poverty, and their squalor, and in their frequent transportation of all sorts of infections and contagions, these immigrants can be likened only to the oriental pilgrims, in whose track pestilence has so frequently followed. It is, indeed, with the extremest rarity that small-pox or cholera has in modern times been introduced into North America by any travelers other than the immigrant class. To take the proper means to guard the ports of entry against the infected persons and baggage of cholera immigrants would probably keep cholera from our midst; to do the same with small-pox immigrants, with the addition of compulsory vaccination and disinfection of personal effects, as an invariable condition precedent to the privilege of landing, would go far toward banishing that scourge from the land; and the importation of scarlet fever, diphtheria, and like diseases might likewise be prevented by adequate measures.

The weighty objections urged against maritime quarantine as a means of protecting the public health from the assaults of preventable diseases imported by sea are only two: First, the alleged failure to keep out these diseases by this means; second, the alleged injury to maritime trade.

In our opinion the first objection finds a complete answer and explanation in the grossly imperfect state and the maladministration of the quarantine defenses.

By a perusal of the subjoined official report of the late Professor Pagliani, of Turin, concerning the introduction of cholera into Palermo, and concerning quarantine in Italy, it will be seen that cholera was introduced into the city of Palermo in 1885 and into Sicily, in spite of the quarantine regulations which had been enacted by the Italian Government. (See also report on cholera in Palermo by the U. S. consul, chapter I, section 3.) It is very certain that the first cases of cholera in Palermo occurred in a court in a miserable, filthy, and poor part of the city, after the washing of soiled clothing and effects which had been smuggled into the town by an employé of a steamer coming from Marseilles. At that time the quarantine regulations required all vessels from infected ports to pass a period of observation at the general quarantine station in the island of Asinara, off the southern coast of Sardinia. This steamer had undergone the regular quarantine of seven days at Asinara, and had subsequently touched at various ports along the western coast of Italy before reaching Palermo—the voyage, after the granting of free *pratique*, extending over several days. It is supposed that these contraband articles were purchased in Marseilles from venders of effects belonging to cholera patients because of their extremely low price, and were smuggled aboard and stowed away in the stokers' quarters until the arrival at Palermo, when they were surreptitiously taken ashore at night, in violation of the port regulations, with the probable connivance of the master of the port.

The outbreak of cholera in Palermo *in spite of the so-called stringent quarantine regulations* has been pointed to as an instance of the futility of attempting by any such measures to guard a locality or a country against the introduction of cholera, and the parallel experiences of other towns along the sea-board of Italy seems to be confirmatory of this assumption. The experience of the Italian Government in their unsuccessful efforts to protect the country by sea and land quarantine during the epidemic of 1884 in Italy caused that country to greatly relax in 1885 and 1886 the stringency of quarantine which they are almost universally credited with having enforced during 1884; and the experience of Italy, as well as of Egypt, France, and Spain,



during this epidemic is pointed to with much gratification by the opponents of quarantine restrictions upon commerce and travel throughout Europe, but in particular by the British advocates of freedom of navigation.

But from my personal investigations concerning these subjects in three of those countries I do not hesitate to say in the most emphatic language that the enforcement of quarantine in Italy, France, and Spain, were it not for the inconveniences and injuries involved, should rightly be regarded as a burlesque. In support of this assertion I have only to quote from the official report of Professor Pagliani, of the University of Turin, made to the Italian Minister of the Interior, concerning the origin and spread of cholera in Palermo in 1885, published as an appendix to the official report of the Italian Government upon the cholera in that country during 1884 and 1885.

At this time cholera was still raging in Palermo, and the quarantine station on an island off the coast of Sardinia was the general station for the whole western coast of Italy. Free pratique from that station, *ipso facto*, admitted without further delay any vessel into any port on the western coast of the Kingdom.

An example of the laxity of land quarantine might be drawn from the experiences in Spain. The failure of the numerous *cordons sanitaires* to prevent the spread of cholera in that Kingdom seems to have convinced many Spanish and other sanitarians that they are worse than useless. A *cordon sanitaire* was thrown around the small town of Chiva, and it was believed by the authorities to be impassable. Yet it is a fact now well established that no less than 127 inhabitants left the town during that time to be inoculated by Ferrán in Valencia and afterwards returned again without the town officials or the commandant of the cordon being aware of it.

#### OFFICIAL REPORT CONCERNING ITALIAN QUARANTINE.

BY PROFESSOR PAGLIANI.\*

In his official report concerning his investigation of the mode of introduction and spread of the cholera epidemic in Palermo during the year 1885, forwarded by Dr. Pagliani, professor of hygiene in the University of Turin, to the Minister of the Interior, is the following account of the manner in which quarantine was enforced at the quarantine station in the island of Azinara, off the southern coast of Sardinia, which explains the facility by which persons with their clothing and other effects could enter Italy and pass from sea-port to interior without any guaranty whatever of protecting the country against the introduction of cholera by sea. After having concluded his investigations at the city of Palermo the distinguished professor describes his departure and voyage in the following manner: "When the steamer was about to depart from Palermo and the passengers with their baggage were going aboard, the port physician came to make his inspection by observing, or at least counting, the passengers and the crew. He caused the effects of the third-class passengers to be carried on deck, and found that six of these passengers had no clothing with which to change during the quarantine, and they were made to go ashore; but in the midst of the hurry of setting sail it happened, and it must always happen under similar circumstances, that, however conscientious the examining physician may have been, he was so occupied with his examinations that it was perfectly possible to conceal suspected objects.

"The steamer sailed under such circumstances that 38 to 40 of the 60 and more individuals of the crew and passengers all came aboard from places considerably infected without further medical observation than that described. Arrived at Asinara, a little steamer, with a port officer and a physician aboard, came out and stopped within a distance of twenty meters from our ship; these officers did not visit us, but simply counted the passengers first, and the crew afterwards—all being marshaled upon the deck for that purpose.

"It was evident that this examination was faulty. In case that the captain wished to conceal a severe patient by causing another to take his place upon the deck with the crew, it would be difficult to discover the deception; further, it is certain that it might easily happen

\* Loc. cit.

that one of the people aboard who suffered with suspicious symptoms but not sufficiently acute could at this distance pass for perfectly healthy and without any concerted attempt at concealment.

"This inspection made, two so-called 'sanitary guards' were ordered aboard, representing two men, too ignorant and incompetent for an intelligent surveillance, capable at most of seeing that no one left the vessel. During the whole duration of quarantine the said small steamer came every day to make its '*inspection*' at a distance, obviously being able to see nothing. In fact, upon our steamer more or less light cases of cholera could occur, although they are as dangerous by their results as serious cases, and these cases could recover without any one aboard being capable of determining whether a diarrhœa which lasted two or three days and the vomiting which accompanied it might be dependent upon indigestion or due to the continuous motion of the ship itself, rather than to the real effect of cholera.

"The quarantine ended, the curious examination which occurred on the day of the arrival was repeated. The above-mentioned little steamer returned. First the passengers, then the crew were recounted and compared with the number indicated in the clearance papers; the steamer without further adieu is given *free pratique*. There was not the slightest thought of inspecting the baggage of those aboard, although, it goes without saying, that in seven days' duration of quarantine there must have been soiled clothing which should be always suspected; there was not the slightest effort made to see if any one aboard might be more or less ailing."

*DELIBERATE DECEPTIONS AND FALSIFICATIONS BY SHIPS' OFFICERS IN ORDER TO ESCAPE QUARANTINE.*

As examples of the deceptions and falsifications habitually practiced by ships' officers of the merchant marine concerning the ships' sanitary condition during the voyage, and of the perfunctory manner in which the duties of quarantine officers are performed in the Red Sea, I would refer to Gaffky's account thereof in chapter I, section 1; and as a striking example, of similar deceptions and falsifications systematically conceived and successfully carried out by military and naval commanders of war ships in their passage through the Red Sea, I reproduce here the remarks of Koch concerning medical inspection at Suez (Koch: Conferenz, Berlin, 1885):

"Concerning the kind of medical inspection that takes place at Suez, the case of the English troop-ship *Crocodile* gives an explanation. Respecting the outbreak of cholera on board this ship something became known at the time through the newspapers; but the accounts are scattered and incomplete. On account of the gravity of the case I deemed it important to trace out its history somewhat closely. Respecting the communications which I shall make relative to it I desire to expressly remark that my information originates partly from the English newspaper, partly from the above-mentioned book of Cunningham, and partly from some private communications made to me during my sojourn in Egypt.

"The ship *Crocodile* had 1,559 men on board, the greater part of whom were invalids, those whose time had expired, and soldiers on furlough, as well as their wives and children. She sailed from Bombay on the 3d of April, 1884, but even on the day before departure, while the troops were already on board, a sergeant suddenly was attacked with cholera, was taken ashore, and died there. Cunningham states that he died of "*diarrhœa with debility*." Other records mention this as a "death from cholera." Cunningham, however, states that both of the children whom the man left behind him and who remained in Bombay soon thereafter were attacked with cholera. I must especially call attention to the wording of this diagnosis, because it frequently recurs. Although this man died of "*diarrhœa and debility*," his bed and clothing were thrown into the sea.

"Soon after the departure of the *Crocodile* a man died April 5 of phthisis; on the 8th of April again a soldier died of "*diarrhœa and debility*;" on the 11th of April a man died of "*choleraic diarrhœa*;" on the same day a child died of "*diarrhœa and debility*;" on the 13th a child died of pneumonia; on the 14th the ship reached Suez.

"At Suez the prescribed inspection of the ship was performed by the quarantine physician, and the interrogatories were made. The ship's surgeon declared that there were during the



voyage five fatal cases, the deaths being caused by "ordinary diseases." The quarantine physician thereupon recorded in the interrogatory that the ship was found in the best hygienic conditions (*visite médicale favorable ; conditions hygiéniques du bord excellente*). The ship accordingly was granted a free pratique, and she at once passed into the Suez Canal. Scarcely had the ship left Suez—indeed, the same day on which the medical inspection had taken place—when a soldier died of an abscess of the liver. This man must therefore have been sick unto death at the time of the *visite médicale*, for his death occurred a few hours thereafter, and it could not therefore be said that the ship was found in excellent hygienic condition whilst there was found on board a patient in a dying condition. At least this circumstance should have been mentioned in the remarks quoted in the interrogatory. On the following day, the 15th of April, therefore twelve days after the departure (from Bombay), while the ship was yet in the Suez Canal, a soldier suddenly fell sick, and now that quarantine was no longer to be feared the disease was no longer called "diarrhoea and debility," but simply "cholera." Arrived in Port Said, the yellow quarantine flag was hoisted and the case of cholera declared to the authorities. Coal was taken aboard in the harbor of Port Said, and sail was then made for the voyage through the Mediterranean. Up to the 20th of April, the seventeenth day of the voyage (from Bombay), when the ship was perhaps off the heights of Malta, other cases of cholera occurred on board the *Crocodile*."

Now, if we had no further account of the cholera on board this ship than the official result of the medical inspection at Suez, a knowledge that on the 15th of April, twelve days after the departure (from Bombay), a man had been attacked with cholera, we might have therewith one more example of late incubation, just such as is frequently related of ships, but herein it is shown how little reliance can be placed upon the accounts of ship's cholera.

Upon the *Crocodile* there was not only a ship's surgeon, but there were also three army surgeons besides, who were returning on furlough. It can not be claimed, therefore, that there was no physician on board capable of making a correct diagnosis. They knew perfectly well that they were cholera cases, but they gave the disease a name which would mislead solely in order to avoid quarantine. This ship's epidemic is also noteworthy, for, as Cunningham states in his book, five of those attacked between Port Said and Malta were attendants upon the sick.

It seems to me as respects the origin of the last cholera epidemic in Egypt, which is yet shrouded in a degree of uncertainty, it ought to be a matter of further interest that several persons left this cholera-infected ship at Ismalia for the purpose of remaining in Egypt. We thus perceive how ships from India can introduce the contagion into Egypt in spite of the medical inspection at Suez. Thus may cholera possibly be brought to Port Said or any other point on the Suez Canal and thence be introduced into Damietta, where great masses of the people attend the fairs.

Furthermore, the history of the introduction of cholera into the Argentine Republic in the latter part of 1880 (see chapter I, section 8) furnishes still another example of falsifications by ships' officers on the one hand and lax inspection by quarantine officers on the other hand. In fact, similar examples could be multiplied almost *ad infinitum* from the history of the various epidemics of cholera, but I have preferred to mention only a few of those furnished by the last epidemic.

### SANITARY CORDONS AND LAND QUARANTINES.

As to *cordons sanitaires* and their almost universal laxity of enforcement, I will refer to only one example from Spain. The small town of Chiva was one of the many which had been "isolated" (?) by a *cordon sanitaire* which was believed by the authorities to be impassable. Well, it is a fact now well established that during the continuance of that cordon no less than one hundred and twenty-seven of the inhabitants of that small town passed out and reached the city of Valencia, where they received the anti-choleraic inoculation, and on their return passed in again through that "impassable cordon."

It is obvious that any hopes of effectively excluding cholera by such a quarantine enforce-

ment are ridiculous in the extreme, and the arguments against the policy of quarantine restrictions, built as they are upon such an absurd enforcement of them, are equally absurd, and yet it is upon such assailable data that not only the Italian and Spanish Governments have practically abandoned their former practice of land and sea quarantine, but also the last International Hygienic Congress at Rome, composed of delegates from all the governments of Europe and America, as well as from India, Egypt, and Japan, had seriously agreed in the protocol of the determinations of that Congress that quarantine by land is useless and by sea is of doubtful efficacy.

The conclusions of Professor Maragliano, of Genoa, based upon a thorough investigation of the manner of introduction and spread of cholera in northern Italy, and of the restraining effects of the local and general measures of quarantine, although enforced as they were in a very perfunctory manner, are in this connection well worthy of serious attention, and they coincide very closely with the results of my own investigations in Spain concerning the subject of quarantine. These conclusions together with a detailed account of his investigations of this matter, are embodied in a brochure, of which, although it is well worthy of being reproduced in its entirety here, I must limit myself to giving only the following extracts:

THE MEANS OF PROTECTING THE PUBLIC FROM CHOLERA, ESPECIALLY BY LAND AND MARITIME QUARANTINE, IN THE LIGHT OF THE EXPERIENCE OF ITALY DURING THE LAST EPIDEMIC.

[From a communication before the Scientific Society of Genoa, by Prof. Edoardo Maragliano, on the 27th of December, 1884.]

I.—Now that the cholera has ceased to disturb our peninsula, and that it can be discussed with the necessary calmness and impartiality, it is well to inquire carefully what influence the acquisitions of science, and especially the most recent, may exercise upon the measures to be adopted for the preservation of the public from this dreaded disease.

And this is the more necessary because, most unfortunately, the least competent have entered into the discussion of this question, and created a deplorable confusion of ideas, which may produce a pernicious effect in the future.

We have witnessed indeed a curious spectacle.

From every side the political press has invoked the name of Science to sustain the most unwarranted opinions concerning measures adopted, or to be adopted, to combat the importation of the disease or limit its diffusion; and it has been with the greatest arrogance that some of them have affirmed and others denied that science would unquestionably condemn this or that measure of public preservation.

It is now necessary that the matter be examined in accordance with the strictest scientific rules. It would be useless to-day to relate the details of the discovery of Koch. From our point of view it is sufficient to point out that the studies of this German micrologist have resulted in: The furnishing of another element of proof that the infectious material of cholera is of a specific nature; is originally from India; does not exist in Europe except by importation, but can multiply and diffuse itself there wherever it may find favorable ground and conditions. That which formerly was inferred from clinical observation Koch to-day, following in the footsteps of Pacini, has only more clearly demonstrated by isolation of the infectious material in the person, if we may use the phrase, of those specific micro-organisms named by him from their form *comma bacilli*.

It is from this exact and essentially etiological idea that we should start in examining and estimating the value of the measures which should be taken in the interests of public protection by the constituted authorities.

From the foregoing, two maxims are most clearly to be deduced: Prevent the arrival of the infectious material and you will not have the cholera; take care that this infectious material finds no soil favorable for its multiplication and reproduction where it arrives and you will have no epidemic.

Let us examine in its details and in its consequences the first of these propositions.

In what manner and by what vehicles can this infectious material be imported from an infected region to one that is immune?



By man, by his effects, by merchandise coming from the same points; but above all by the sick, their excrementitious material, principally alvine evacuations, and by their personal effects which have been soiled by the same material; not by means of the air. Koch, indeed, admits the possibility only of transmission by air in such a manner that this means can not be regarded as capable of transmitting it from one region to another. The air may, according to him, become the vehicle of the infective material when it contains in suspension a nebulized liquid in which that material may be found.

This condition might be met with, for example, in Alexandria, Egypt, near the new port where the sewers empty. Patients being in the city, sick of the disease, and the infectious material being conveyed by means of the sewers, the sea-water might become contaminated by the said material; and, standing near the shore, one might respire the salt-water spray, which in such cases would be dashed into the air, as is the case always in proximity to the sea. Although there are those who believe in other modes of infection by the atmospheric air, all those who do so hold that the infection must take place at a minimum distance. The possibility of the transmission by the air can not, however, be invoked for the transmission of the disease from one infected nation to another which is yet free from the disease. It is necessary to well establish this point as a fundamental principle, for the benefit of those journalists who rave about microbes transported upon the wings of the wind.

Now then, if man, his effects, all the things coming from the locality where the disease exists, alone can be the vehicles of the infective material, the following propositions must be clearly deduced: Rigorous, absolute suspension of all communication by man or by things with the infected locality constitutes the most secure and infallible means of public preservation, and it may be expressed in the words of Eichorst. When cholera exists in one country other countries can protect themselves only by means of the most rigid isolation.

This is the absolute and exact answer which science gives to those who invoke her counsel.

It is a response which will please few of those who desire to bring science to the service of party exigencies or of local interest, or who pretend to see in her advances that progressive mutability which is met with in industry or trade or is seen in administrations and policies of government.

These maxims are mediæval, it is said. Be it so. We answer: it is sufficient for us if they are true. If, as is to-day perfectly demonstrated, the ideas of the middle ages concerning the etiology of infective diseases were in many points more exact than those which have come to predominate in the last thirty years, ought we to deny the truth and the results of honest observations, of irrefutable researches, solely because they confirm in part opinions which prevailed in the middle ages?

For example: Three centuries ago phthisis was held to be an infectious, communicable disease, and in the sixteenth century, in Florence and in other centers of Italy, the Government treated the effects of phthisical patients with all the rigorous precautions which to-day science suggests for infective diseases. Those practices, those ideas, date from antiquity; but to-day they revive again in their greatest splendor because science, with irrefutable experimental proof, has demonstrated the truth of conceptions which in those times were based only upon empirical observation.

What more? When it shall be irrefutably demonstrated that the bacilli discovered by Koch are the pathogenic agents of cholera another ancient belief, another mediæval superstition will have its confirmation in the scientific conquests of to-day.

The pathogenic value of the comma bacilli being once confirmed, who would indeed deny the possibility of planting this terrible disease in a healthy country? A person having the wickedness as well as the skill in laboratory manipulations by putting into a reservoir of drinking water the fluid cultures containing the morbid germs could easily create a cholera epidemic in a given locality. But let us leave aside these profitless declamations. Let us bow to truths scientifically demonstrated and take counsel from them without prejudice and without endeavoring to cloud them in order to escape the conclusions which may be deduced from them.

II.—To him who asks for rules of public health intended to prevent the importation of the germs of cholera we must reply, absolutely and exclusively upon scientific grounds, that all the rules required are found comprised in a rigorous and absolute suspension of all intercourse by man and things with an infected locality.

Upon this point all are agreed, and aside from the definition of the individuality of the infective principle which may still be controvertible, every one recognizes as beyond doubt that the infective material of cholera is never elaborated spontaneously through any conditions of an unhealthy place, but that it is always imported. Respecting this, we are glad to be able to say to-day that in Italy the question is no longer discussed, any more than it is in Germany.

Differences of opinion commence, however, when we come to consider the practical application of these scientific maxims to the protection of the public.

We will examine now the following questions in their order:

(a) As to the general defense of the continent of Europe against the importation of the infective material from Asia.

(b) As to the individual defense of European nations against each other after the infective material may have been imported into Europe.

(c) As to the defense against each other of the various localities of the same State when the infective material shall have penetrated into any part of the latter.

As respects the first case, the general defense, that is, of the European continent, there is a general agreement concerning the policy of applying the maxim above enunciated in all its severity and in its extreme consequences.

I shall certainly not dilate upon this point, which was perfectly and almost unanimously settled by the International Conference of Constantinople in 1866 and by that of Vienna in 1874. It is indubitable that if the quarantine measures agreed upon for the ports of the Red Sea and the Caspian Sea, where these strategic points of defense are well guarded, should be always enforced in all the rigor possible, the inhabitants of Europe would be in the great majority of cases protected from an invasion of cholera.

But not always, and the present epidemic which menaces Europe is a proof of this, for the infective material arrived directly at Toulon from Tonquin without touching Egypt and without passing through the points of international defense. It can be proven that the importation of the disease eluded international observation and that the defense of Europe rested in the hands of a single nation, which, through egotism, or selfishness, or natural indolence, allowed the enemy to triumphantly enter. It is on this account that there is a necessity for individual defense of the nations of Europe against each other.

The measures proposed and from time to time enforced for the accomplishment of this end are the following: (1) Absolute isolation; (2) maritime quarantine; (3) land quarantine; (4) medical inspection.

Absolute isolation was attempted by military cordons which should absolutely prevent the entrance of every one into a State still healthy.

Maritime and land quarantines, the quarantine being passed upon ships or in lazarettos before permission to enter upon the territory of a State.

Medical inspection as well of those coming from sea as over land.

Maritime inspection ought, according to the decisions of the Conference of Vienna, to be performed by means of medical officers, who should visit the ships and examine the crew and passengers. If the ships proceed from an infected point and have had aboard attacks or deaths from cholera, but are not thus afflicted at the time of their arrival, all of the healthy should be admitted to "free pratique" after a rigorous disinfection of their persons and their effects. The ship and the merchandise should be also disinfected.

As to arrivals by land, medical inspection should include all travelers who wish to enter the State by rail or in any other manner. To that end sanitary officers should inspect travelers at their arrival and during their journey. This should be done at stations previously established along the railways and at the points of their arrival whenever they present suspicious symptoms. All those who exhibit no suspicious symptoms should be allowed to go free.

The effects of travelers or merchandise coming from infected localities should be disin-



fect. The process of disinfection should be capable of destroying infective material which may be found in anything coming from a region infected by cholera.

Such is the system adopted by Germany, France, and Switzerland.

What system is preferable? If in determining the criteria which should guide us in providing for the defense of a nation against importable diseases a government were able to follow solely, exclusively, and without hesitation the knowledge which is possessed concerning their etiology, the system of absolute isolation (it being possible to enforce it and the proper means being at hand) would constitute the most perfect and the most complete of all measures of defense, would be capable of furnishing the necessary guaranties, and would be the only one responding to the requirements of science. And yet these measures, it is asserted, are condemned by science and are inefficacious.

But if they are not condemned by science they are impossible to enforce on account of insurmountable difficulties, especially when a large nation is in question, because of the exigencies of trade and commerce and of civil relations. It being necessary, therefore, to renounce measures of absolute defense by reason of their impolicy, there remain those of relative defense, viz, quarantine by sea and land and sanitary inspection.

Quarantines have many and vigorous opponents. Whether land or sea quarantine is in consideration the formation of lazarettos as well for those proceeding by land as for those arriving by sea from centers of infection is involved. The objections deserve to be examined.

It is perfectly true that quarantines may cause the collection in lazarettos at the frontiers of many individuals suffering with the disease, and it is also perfectly true that, absolutely speaking, each point at which cases of infective disease are found collected together may be considered and denominated a center of infection.

All this is true, but can it be invoked in condemnation of the system of quarantine? Is it true or not that the patients assembled there in those lazarettos were individuals who would otherwise have penetrated into the State? Is it true or not that by collecting patients together here and there more centers of infection might be created, and in points not prepared for the emergency, where, on account of special local conditions and defective measures devised, the authorities might be impotent to prevent the propagation of the infective material? When a country has the misfortune to border upon another in which cholera exists, and therefore can not but receive infected persons, is it not perhaps preferable that the latter should be collected where the topographical conditions are favorable and where there are proper means, previously provided, capable of preventing this center from becoming dangerous to the State desirous of protecting itself? Is it not preferable to give battle to the enemy upon ground previously chosen and studied rather than accept it where and when he may please to offer it?

But let us pass on, for we have already wasted too many words in destroying this puerile objection, presented by the laity.

But besides this common objection to systems of quarantine yet others are raised.

It is not denied that quarantine is capable of securing the effect proposed, but it is held that in actual practice it is useless because communication by land (except in the case of islands) between affected European nations and those which are healthy is uncontrolled by an adequate surveillance.

This is a reasonable objection, for only maritime quarantines between European nations with whom communications by land are possible and rapid are purely and simply an absurdity. They can not prevent public misfortune and they occasion very great injury to the trade and navigation of the countries which adopt them. These objections, however, apply to maritime defense, which is a complement of that by land.

Land quarantines which are intended as complementary to sea quarantines are savagely and strongly opposed. The objections may be mentioned under the following captions:

- (1) The impossibility of enforcing them.
- (2) The damage which they occasion to the commerce of the nation.
- (3) The protective effect which they produce is insufficient.

Let us examine these objections.

The impossibility of enforcing land quarantine should not be affirmed since the Italian

Government established and organized thirty-one land lazarettos at the frontier in a few days. This experiment has perfectly demonstrated that a system of quarantine by land planned and organized in moments of calmness, studied out in all of its details in such a manner as to meet the requirements of every scientific exigency, is undoubtedly attainable.

The second objection is more serious.

The commerce of a nation is a thing intimately related to its wealth, and the hygienic condition of a population is in almost direct dependence upon their financial condition, so that this objection has a double aspect, economic on the one side and hygienic on the other.

But we believe that a minute analysis of the facts would remove most of the force of this objection, if not, indeed, destroy it entirely.

The measures of defense against the importation of the disease ought to be separately examined as to their effects relative to persons and relative to merchandise.

Relative to persons it is a fact that they are disturbed and their movements are rendered less active by land quarantines.

But the movements of merchandise are little affected by land quarantines. They are so by sea quarantines, but these are to-day far less objected to; yet, considering the relations between the various nations of the continent of Europe, they should have indeed but little importance, for trade between them is conducted over land. Now, we must admit that, in view of these peculiarities of European commerce, the movements of persons is a factor of much less importance. To-day it is the telegraph which conducts and concludes all large transactions. When, therefore, the post and the telegraph are free, when merchandise can circulate from one nation to another, commerce is little or not at all damaged by the existence of terrestrial quarantines. The war made in the name of commerce upon maritime quarantines formerly was waged *altogether in consideration of merchandise and not of persons*.

This reasoning is as simple as it is obvious, and, in our opinion, it destroys one of the gravest objections which are urged against land quarantines, if it does not altogether remove the others. The habit among the masses and with the political press of observing slightly and very superficially the daily phenomena of social life, without understanding the factors, prevails too much among us. If with land quarantine the harvests diminish, as also trade with France, it is of course the quarantine which is at fault! Thus the masses reason, and jump at conclusions.

But why is not another possible important factor taken into consideration, for it seems to me a principal factor in this diminution of trade, that is, that the epidemic itself causes this diminution? When the figures respecting the commerce between Italy and France during the present epidemic, while land quarantines were enforced, shall be compared with those relating to commerce during the preceding epidemic, while the frontiers were free, we shall have, I am convinced, a proof of the irrefutable fact that not the land quarantines but the cholera itself was the cause of the paralysis of trade.

How many times have we not seen the natural effects of malaria and of syphilis attributed to quinine and to mercurials. We who live in the first commercial city of the kingdom, having a custom-house which alone gives to the treasury of the State as much as all the other custom-houses taken together; in a city where from their experience business men are in a position to see and estimate the damages which follow an epidemic of cholera, as well as those which result from the measures of quarantine, we have not found any one to complain of the delay which travelers were obliged to suffer at the frontiers. Our chamber of commerce, through its president, expressed itself, on the contrary, as satisfied, and publicly thank the Government for these quarantines.

And we believe that every person in Italy who knows how to distinguish the interests of that extensive traffic and of commerce, through which the heart of a great nation beats, from that of the boarding-house keepers, who alone experience actual damage from the quarantine measures enforced at the land frontiers, will be of a similar opinion.

Let us consider now the objections which are raised concerning the insufficiency of the measures of quarantine. These objections, we have already said, are rational and well founded.



We must admit it to be impossible that all persons coming from an infected nation shall, before entering into the State, undergo quarantine at the land frontiers.

In the same manner that the customs examinations are escaped so sometimes sanitary inspection is avoided.

Nor is this all. It must be further admitted *that it is quite possible that, notwithstanding the fact of having undergone quarantine, some persons coming from a locality attacked by cholera* may introduce the infective material into the State which he desires to enter. It can be carried in their effects and in their persons by means of that simple and innocuous affection—really the beginning of cholera—designated as *choleraic diarrhœa*.

Those suffering with it upon their arrival do not present, it should be remarked, any manifestation of disease worthy of note. They experience only some diarrhœal evacuations, accompanied by a peculiar weakness—phenomena which may not be followed by any serious consequence.

These diarrhœas escape the attention of the lazaretto physicians; those suffering from them are given clean certificates; nevertheless their evacuations contain the germs of the disease, whatever they may be, which, wherever they arrive, are capable of creating a focus of infection and of finally becoming the starting-point of a severe epidemic.

But between “being insufficient,” which we have indeed admitted, and “being useless,” as some claim, there is a wide difference. It is an indubitable fact, thanks to these measures, *that persons who might fall sick with cholera and die here and there in the various communes of the State are stopped and confined in the lazarettos at the frontiers.*

In these lazarettos, furthermore, the operations of cleansing and disinfection of the effects of persons proceeding from an infected locality, as dangerous to public health as the sick, and even more so, can be carefully and thoroughly practiced.

The measures of quarantine, therefore, *hinder the arrival of infectious material, if not in all, at least in many parts of the State.* If after the entrance of the disease into the country some localities shall yet become infected by subsequent transportation from the interior, *we can not in any manner deny that the preventive measures enforced may have retarded the spread of the disease—that they can have a decided importance and save cities and entire provinces from grave epidemics.*

A word upon the sanitary inspection of travelers. The objection of insufficiency applies still more to this than to the quarantines. Whilst the quarantines arrest the *greatest number of those in whom the disease already exists in the latent form, the sanitary inspections discover only those in whom the disease is already manifest.*

These may, nevertheless, *become useful measures and serve a useful purpose in this regard—most useful in those cases where the medical inspections are accompanied not only by disinfection, but also by washing, and, further still, by destruction of the personal effects of the traveler.*

After the critical examination which we have just made we ought, therefore, to conclude that non-infected nations for defense against infected nations do not possess preventive measures of any absolute, but only of a relative, value as a means of defense against infected nations. Should we, however, on account of their insufficiency, advise the Government to renounce altogether these possible means of defense? We do not think so. If the diverse means of prevention which had been made use of by governments in the interests of nations and of society must, on pain of being abolished, respond in a complete and absolute manner to the necessities of those who have selected them the action of governments would be reduced to absolutely nothing. We could not find a single measure among the innumerable ordinances of the most civilized nations of the world capable of withstanding a systematic criticism. From the most potent means of offense and defense with which a nation girds itself to repel an armed foe to the minute and multifarious disciplines which in the interests of disease are enforced for the moderation and regulation of the intricate interests of active human life nothing is found which responds in an absolute manner to the requirements of the case. What is the fortress capable of really arresting an invading army? What is the armor which per-

fectly defends the sides of a ship? What is the provision of law which represses abuses in an absolute manner?

Arguments thus sophistical and capricious are usually ended by invoking science in defense of passions with which science has nothing to do. To say, for example, as is said, that science condemns land quarantines because they are difficult of enforcement, that it condemns them because they are damaging to commercial interests, is to place too small an estimate upon the amount of intelligence and upon the degree culture of those who read.

It is recognized, therefore, and well it is so, that in order to defend states from invasions of infectious and epidemic diseases such as cholera governments have the duty and the right to adopt those measures of prevention which are possible to enforce, although they may have a value not absolute but relative. Nor must we forget that it is incumbent upon us physicians to point out all the possible preventive measures, at the same time indicating those which have the best scientific warrant. To the governments belong the duty of selecting from time to time those which according to circumstances are advisable for securing the greatest possible protection to the multiple interests of the nation and which meet the special conditions encountered.

But it ought not to be forgotten that the circumstances under which the danger of importation of the disease presents itself are various.

Imagine that cholera has broken out in a neighboring nation, but in a part of it quite distant from the frontier, a part with which there has been no active communication, and that the existence of the epidemic can not cause a current of emigration from that locality towards the national frontier, well, in such a case quarantine is unnecessary. In such a case medical inspection of all travelers, careful disinfection, and if possible the destruction of their effects will be sufficient.

Imagine the case, on the contrary, in which the morbid focus exists at a point near the frontier and crowds of emigrants are moving towards the adjoining nation; then simple inspection will no longer be sufficient and special measures of quarantine will be most useful on the one hand for limiting this current of emigration, and on the other it will permit of more rigorous and more thorough medical inspection, and will allow the disinfection and the cleansing of the effects of the travelers to be more exact and perfect.

Other contingencies will from time to time give occasion for still further variations; thus, for example, we may close the frontiers upon every side which is menaced, and when it is indicated by special conditions, at the other frontiers we may subject the travelers only to a personal medical inspection and to a rigorous cleansing of their effects. Those who have traversed two or three hundred kilometers of railway and have spent some hundreds of francs in order to enter the country at a very distant part of the frontier for the purpose of avoiding the quarantine are relatively very few and are persons in good financial situation. An accurate inspection is on the one hand quite difficult, whilst on the other hand the probability that the disease may be imported by them is remote and in fact exceptional. Cholera is an infirmity which in great part exclusively preys upon those who live in want; on the contrary, we must agree that people well to do rarely carry their effects impregnated with infective material. We shall indeed find among the latter none who, for example, carry with them the effects of a person dead of cholera or which a cholera patient has worn. It is very easy, however, to find among the unfortunate many who are unwilling to part with objects which constitute their whole property and which they can not easily replace.

The duration of quarantine ought, however, to be brief, not more than two or three days, with authority of the physicians to shorten or prolong it according to circumstances. The period of incubation at most is, according to the opinion of the most accredited pathologists, held to be about three days.

It is true that sometimes it appears to have a greater duration, even of some weeks, but these are exceptional cases in which it may be doubted if this prolongation of the incubation may not be more apparent than real, because the infection might have occurred later than it seemed through infective material existing in the effects of the attacked; the latter after having departed from infected centers in a perfect state of health, may become infected beyond the



centers themselves and in a locality perfectly healthy, by these effects if they contain the morbid germs.

The duration of quarantine should be the same for maritime as for land quarantine; the disparity of the present practice which imposes twice or triple the length of quarantine upon those who desire to enter the State by sea is an absurdity.

Finally, we must recognize the fact that divers will be the precautions to be taken by nations, according to their internal hygienic condition, according to the good organization of their provincial hygienic service and according to the intelligence of the population. When a government is convinced that the morbid germs, wherever they may chance to be carried will be extinguished and will not in any manner find the means of multiplication, it may leave its own frontiers entirely open and limit itself to medical inspection, whilst, on the contrary, the measures of protection to be enforced should certainly be much more severe and rigorous in the case of nations in which unfortunately, as in ours, the illiterate may be in large numbers, the provincial hygienic service with a few exceptions non-existent or disorganized, the intelligence of the masses very limited—when, in fine, a government is convinced that in many points where by chance the morbid germs may arrive there will be found a soil abundantly favorable for its reproduction, such as in Busca, Naples, Spezia, and the like. The method of selection of the principal measures of defense by different nations by taking as a standard of comparison the measures of defense put in practice by others is therefore erroneous. If the measures of defense are to be useful and efficient they must have reference to the special conditions of each nation. Nor on this account would it be possible to adopt for all the European nations a system of uniform defense against those which might perchance be infected. Whilst the adoption of collective preventive measures by the nations in order to prevent the importation of the morbid germ from India into Europe might be very useful, yet those measures of protection which each nation should take when the disease has reached Europe can no longer be uniform. The effort to interest an international congress in this matter would be absurd, because this would be to treat of measures of protection incident to the different internal condition of each nation.

III.—The question of internal defense is presented unfortunately every time that an epidemic of cholera occurs in Europe. Early or late the disease usually crosses the national frontier and causes more or less damage, according to the manner in which the internal defense has been provided for and is conducted.

The security of the internal defense depends altogether upon the greater or lesser accuracy with which the governmental and the communal authorities comply with the requirements of hygiene. The infectious germs once arrived in a locality, they will never be able to do any damage if they do not meet with a favorable soil for their reproduction. When there is diligence exercised in removing all the conditions which can contribute to this reproduction the enemy can be fearlessly defied, because deprived of its sustenance it must die, and it is the knowledge of being thus powerfully guarded that creates the security with which some of the most civilized nations of Europe allow, without any attempt at defending the frontier, free entrance to the disease, convinced that it can not spread.

But unfortunately such a security can not exist everywhere, because everywhere there is not the consciousness of having removed every condition capable of supplying sustenance to the morbid germs. In the latter case the effort at internal defense should be inspired by a determination to contest the ground step by step with the disease and to protect as much of the country as possible. The means suggested for this end are the following:

(1) Rigorous isolation of the first attacked, of their families, of every one who has direct or indirect communication with them, conjoined with rigorous disinfection.

(2) Rigorous isolation by means of sanitary cordons of the localities in which the large number of cases renders partial isolation no longer possible.

(3) Enforcement of all advisable measures for discipline and for limitation of emigration from the infected to the healthy localities when it may not be possible to insure isolation by the establishment of sanitary cordons.

A critical examination should be made of those measures whose efficiency has been variously

appreciated and of which some were recently subjected in Italy to an active and unjustifiable opposition.

The utility of rigorous isolation of the first case and of careful and thorough disinfection has come to be universally admitted for to-day no one any longer attempts to deny it. But it must be known that it happens very frequently that these measures of prevention are not applied to the first case, either through the fault of the physicians or through the fault of the authorities, and indeed frequently through the fault of every one. These deplorable omissions through which destructive epidemics often originate proceed from the uncertainty of the physicians, which we do not wish to stigmatize as culpable. They have a patient who presents the common aspects of the disease, a diarrhoea, with vomiting, cramps, cyanosis, alidity, and aphonia, but they find that the patient has recently committed an imprudence in diet or that he has drank heavily.

It is for them an attack of indigestion complicated by acute alcoholism, but they forget that indigestion and alcoholism never give rise to such phenomena. They even allow themselves to hazard the term *cholera nostras*, being very much biased by the absence of facts which prove the possibility of infection, and they forget the precept taught by all the pathologists that when cholera has passed the frontiers of a nation there is no longer room to speak of *cholera nostras*. The conditions and times of infection are so subtle that often it is impossible to appreciate them. In the midst of this uncertainty no attempt is made to destroy the infective materials and to prevent their circulation. The patient dies, but many times even this result, which unfortunately is very significant, does not suffice to open their eyes. The autopsy is made; it is found that the deceased had a heart trouble or a pulmonary cavity or a cerebral softening and then all anxiety is removed; the cause of death is satisfactory and is found. The very great error is committed of not comprehending that *the morbid symptoms presented by the patient do not belong to those anatomical lesions of the viscera met with and can not be invoked to explain the death which followed the symptoms in question*. And at the same time still another no less grave error is committed by not remembering the teachings of experience, that the Asiatic disease attacks by preference persons who are already seized with another infirmity.

We do not discuss the cases in which the uncertainty of the physician has a less plausible and less honorable excuse, viz, the fear of a mayor who does not wish that cholera shall be declared to exist in the commune over which he governs, or the fear of a political journal which, making itself the interpreter, as sometimes happens, of the crude notions of the masses of incompetent persons, sends to Coventry the physician who fulfills his duty by declaring a suspected case.

The physician who has a knowledge of his proper duty ought not to allow himself to be overcome by such fears, but too often it is observed that sometimes those who have the courage to perform their duty suffer for doing it. I have seen a municipal physician obliged to tender his resignation because he dared to affirm the death of a lady from cholera which the head of the communal administration most energetically insisted should be attributed to indigestion. And I have seen, even in Genoa, a distinguished physician subjected to unjust sneers and indignities, who, conscious of his duty, declared three cases of cholera existing in a populous quarter of the city; but his declaration caused the municipality to take the necessary steps for the extinguishment in its origin of a focus of infection, and gained the applause of those who were competent to appreciate his act.

As to the communal authorities, all without exception show themselves unwilling to recognize as such the first case of cholera, but, denying it, they have often nevertheless the good sense to enforce isolation and infection; there are, however, those who unfortunately are so blind as to remain inactive. If the latter are inexcusable the former are not blameless. The announcement of the first cases has the greatest importance from a special point of view. In every center there are always persons instinctively timorous, viz, those who flee—and those do well to fly who do not possess a calm mind—at the first announcement of the outbreak of the disease. It is preferable in the interest of the regions not yet affected where they halt that the timorous depart when the infection is not yet extensive in the city whence they depart.



Those who leave at the outbreak of the very first cases are not likely to carry the disease elsewhere.

Under this miserable system of concealment it often happens that precipitous emigration occurs, and on a large scale, when the epidemic has almost reached its height; then the seeds of the disease may be sown by the fugitives all along the route which the latter follow.

Although the advisability of isolation and disinfection of the first individuals attacked is generally admitted, it is difficult, however, to practice them upon every person who may have been directly or indirectly in communication with the person attacked. These measures are enforced ordinarily in the large cities, but rarely in the small communes, where the mayors very frequently, either through ignorance or unwillingness to interfere with particular interests, refuse to enforce such measures. The infected foci may be developed right at the gates of large cities which, after having spent enormous sums in measures of defense, find themselves invaded by the disease through the culpable carelessness of a rural municipality.

Should isolation continue after the occurrence of the first cases? Yes, without doubt. As long as the infection does not spread over the whole commune it is necessary to persevere in isolation and in all its associated measures with indefatigable constancy. The municipality of Milan has furnished a splendid example of the great advantages of perseverance in order to mitigate and limit the diffusion of the disease and lessen the extent of the damages which follow.

When on account of the number of cases isolation may be no longer possible, or when the infection has spread throughout the whole or a large part of a commune and partial isolation is no longer applicable, the question arises of the segregation of the focus of infection by means of a sanitary cordon.

It is against this measure that the power of rhetoric has often been hurled, and science, commerce, and humanity have time and again been invoked to oppose it.

It is not always possible to enforce this measure wisely. Often it is impracticable because large commercial centers are in question or because special topographical conditions prevent it. But when not dealing with large cities and when it may be practicable isolation is a most excellent means of internal defense.

In estimating the value of it the end for which it is practiced should not be forgotten, viz, the maintenance of the immunity of the greatest possible portion of the country which remains still uninfected. It is necessary to keep in view the advantage of the whole nation even more fully than the eventual damages which may be suffered by the inclosed locality.

But in reality the damages which the infected locality suffers from isolation are not those which are painted with so much exaggeration. The commercial damages, after the moment that the route of circulation of merchandise is free, are imaginary. So also are the damages which follow the enforcement of hygienic measures, because those who are found in the most crowded and most afflicted centers are they who, unfortunately, have not the means of abandoning their residence.

Some break through the cordon, and that proves that this measure is not capable of fulfilling with absolute perfection the ends for which it was devised. But the same imperfections have been observed in the application of all other measures of international defense. And it should not be forgotten that if the enforcement of those hygienic ordinances of which in given cases infraction is possible ought to be renounced we should logically arrive at the abolition of all discipline. What is important to recognize is this: many times isolation by sanitary cordons has saved an entire region from infection; many times it has retarded and limited the diffusion of the disease. Often, it is true, this measure has not succeeded, but this negative result is not sufficient to invalidate the positive ones. It should be remembered that opportune measures may obviate the infractions by rendering them unnecessary. It might be possible, in fact, to permit the escape of a single person *without producing any effect*—a medical examination, careful washing, and disinfection of the personal effects being first performed—for, as we have already said, the most dangerous vehicles of the infective materials are the personal effects, especially those inclosed in valises, boxes, etc., more dangerous than those exposed continually and habitually to the air.

But sanitary cordons are not always applicable, although the cases in which it is possible to make use of them on account of special topographical conditions are rare. In such cases it is necessary at least to adopt measures which will impede the escape from the city of persons already sick, as well as clothing and effects of every kind, measures which will guarantee the absolute cleanliness of the baggage of those who leave. In such cases the following measures will be useful:

(1.) Medical surveillance, cleansing, and disinfection of the effects of the travelers at the point of departure.

(2.) A careful and continuous medical surveillance during the journey of the vehicles containing persons who leave the infected locality.

Should the non-infected communes adopt measures of defense? Yes, certainly. In France and Italy the presence of the Asiatic disease has produced in some communes such a panic as makes it advisable to adopt measures which would be inadmissible for an intelligent people. Quarantines between communes were instituted and enforced by the shotgun without any distinction whatever of persons, no matter whence coming. Such are not the measures of defense which a great nation should permit its individual communes to enforce. A government ought to take every possible and advantageous precaution to prevent invaded communities from infecting the healthy, but it should at the same time protect the rest of the country from interference with the free movements of the inhabitants.

To the municipalities still free of the disease there remain numerous other means of legitimate and intelligent defense.

Place the commune in such good hygienic conditions that the importation of the germ can not cause an epidemic. The splendid results experienced by the city of Genoa prove that this can be done. That city was infected in an unforeseen way through its drinking water, the infectious germs entering and spreading throughout the whole city in a very insidious manner. The cause of infection being removed, the disease was suddenly cut short, a proof that, although the germs had been introduced, the internal conditions favorable to their nourishment and activity did not exist.

It is necessary that those communes of an infected region which are still immune should give close attention to their water, especially to the drinking water, because to-day it is undoubted that water which proceeds from an infected locality may convey the morbid germs and propagate the disease. The idea that running water soon becomes incapable of transporting living morbid germs is proven to be completely false. Experience demonstrates that cholera, as well in India as in Europe, is propagated along the water-courses. If one traces out upon a topographical chart of a region the localities attacked by the disease it will be found that they correspond to the water-courses or to the various ramifications of some large aqueduct. This truth had ample confirmation in the diffusion of the epidemic in the neighborhood of Pancalieri, in the province of Turin, of that of Busca, in the province of Cuneo, and of those in several communes in the neighborhood of Parma. In these localities the diffusion of the disease took place along the water-courses. The same is to be said of the diffusion of the disease in the large cities, where it is seen to spread among the inhabitants of houses furnished with water from the same aqueduct, whilst those inhabitants in houses of the same locality supplied with water from different sources remained immune.

This capacity of potable water of being a vehicle not only of cholera but of many other infectious diseases is a popular belief to-day in England, and Marais has demonstrated it by very many illustrations of its truth made before the Academy of Medicine of Paris. Authorities should recognize the fact that any water, however good it may be, may accidentally and temporarily become contaminated, and when there is reason to suspect this the most radical remedy is to render the use of it impossible by stopping the supply when circumstances make this possible.

After the measures of the public and private hygiene, next in order of efficiency are those looking to the destruction of morbid germs. The most rigorous insolation, the most perfect disinfection, when they are conducted scientifically and conscientiously, meet the requirements in the great majority of cases. Finally, careful watchfulness that infective material shall not



be introduced from the foci of disease, or at least shall not enter insidiously, may render the defense complete. Those maxims many times repeated by us must never be forgotten, viz, that an individual attacked with cholera is less dangerous than a healthy person who may carry with him effects impregnated with infective material. An intelligent surveillance at the point of arrival will be specially useful in preventing the entrance of soiled clothing and of hindering the entrance of persons or effects of a doubtful character, to the end that the latter may undergo a careful cleaning and a real disinfection. Finally, there should be a medical inspection in order to prevent the entrance of the sick.

Such preventive measures, as we will demonstrate with facts, succeeded in protecting very many communes of Italy near to dangerous foci of infection, although in some of them the morbid germ had been imported by individuals sick of cholera who had come from infected places.

IV.—Having thus explained the principles which, in my opinion, ought to guide the authorities in the adoption of measures of public protection against invasions of cholera, it is now time to consider what were the results of those measures which were put in force in Italy during the last epidemic.

It is an interesting study because we may be able to profit by the information which we have obtained from painful experiences. Convinced of the importance of such an investigation, I have attempted with the greatest diligence possible to collect the necessary documents. In the midst of contradictory, and, I admit, false reports, it was necessary, it seemed to me, to furnish myself with data obtained from original sources. I instituted, therefore, a species of sanitary inquest. I obtained from the Government all the data which they could furnish me, and I addressed besides the following interrogatories to the various communes.

#### INTERROGATORY FOR THE COMMUNES WHICH HAVE HAD CASES OF CHOLERA.

- (1) When did the first confirmed or suspected case occur ?
- (2) Name, age, and condition of the attacked ?
- (3) Did he come from a locality where cholera existed ? What ?
- (4) Was there quarantine at the borders by sea or land ? When ? For how long ?
- (5) If the attacked did not come from an infected point, had he communication by relatives or by domicile with persons coming from infected points ? If so, indicate them.
- (6) Had those persons coming from infected points with whom the attacked had been in communication undergone quarantine ? Where ? When ?
- (7) Was the patient cured ?
- (8) After this first case were there others ?
- (9) Name the second, third, fourth, fifth case, stating the relations by consanguinity or by domicile, and giving all the information already asked for in the first case.
- (10) What measures were taken on account of these first cases ? Were the latter rigorously isolated ? Were their effects disinfected ? In what manner ?
- (11) Was there a sanitary cordon established around the whole commune or a part of it or in conjunction with other communes ? For how long ?
- (12) Were there cases of cholera among the soldiers forming the cordons ? How many ? With what result ?
- (13) Were there cases of cholera in the commune to which those constituting the cordon belonged ?
- (14) Did there exist in the commune persons returned from France or from other infected regions ? About how many ? Had they undergone quarantine ? Where ?
- (15) How many attacks were there altogether ? How many deaths ?

I have collected, therefore, a series of reports which I have reason to regard as truthful, and from which I have been able to learn what were the results of the measures adopted for the public protection.

The defense of the Kingdom against the importation of the disease was based on two different methods of quarantine.

The immigrants were either retained in quarantine stations appropriately established at the frontiers, or they were taken aboard steamers and transported at the expense of the Government to the lazarettos of Varignano and Nisida to undergo a period of quarantine. The immigrants thus subjected to special observation were altogether 56,237.

The quarantine stations established at the frontiers were 33 in number, of which 19 were upon the French frontier, the others being upon the Swiss and Austrian frontiers.

The number of persons received in these 33 lazarettos was 46,044, of which 42,348 were at the expense of the State and 3,696 bore their own expenses.

Those received in the two maritime lazarettos were 10,193, of which 10,137 were supported by the State and 56 supported themselves.

Apropos of all the many and various charges of uselessness made against those measures of quarantine which were enforced upon the immigrants, it is worth while to learn if these accusations are well founded, or if, on the contrary, the country has been benefited by such measures of defense.

To those who will weigh the evidence impartially it would seem that the quarantines have retarded the invasion of our country by cholera.

If, in fact, we examine the statistics of cholera in Italy we find that no epidemic focus made its appearance until the end of July, 1884.

On the 28th of June, it is true, we see the first case of cholera reported in the commune of Saluzzo.

It was that of a certain woman, forty-four years of age, who came from Toulon and had returned to Italy before the quarantine observation was established at the frontiers. She soon died. Measures were successfully taken by the local authorities to prevent the development of other cases, and this first case was not followed by others.

This occurrence of Saluzzo, therefore, can not be raised against the efficacy of quarantine. The case occurred in a person who had crossed the frontier before it was established. Neither can it be said from this first case that because the case was not followed by others the quarantine was useless. As we have already pointed out, no epidemic broke out in Italy before the end of July. It is, in fact, between the 25th and 30th of July that the epidemics of Pancalieri and of Garfagnana began. To him who will consider how large was the number of immigrants at the first outbreak of the epidemic in the south of France and how much greater it might have been if barriers had not been opposed to the current, it will be manifest that the immunity during the month of July ought to be in great part attributed to the system of quarantine adopted. If then we examine the number of the individuals attacked with the disease in the quarantine stations and treated there, the truth of our affirmation will be still more manifest.

Consulting these data we find that an individual journeying to Lucca fell sick with the disease on the 10th of July, and Lucca did not have a case of cholera until the 23d of August.

On the 15th of July there was a case in the lazaretto *en route* to Asti, and Asti remained free of the disease until the 3d of October.

Another going to Venice was stopped on the 19th of July, and Venice did not have a case of cholera until the 20th of October.

Another on the 25th of July we find returning to Bovis, where they did not have cholera until the 12th of September.

Another individual traveling to Soresina was attacked with cholera in quarantine on the 21st of July, and Soresina remained free of the disease until the 22d of September. Four individuals bound for Naples are attacked in quarantine on the 22d of July, and that city, which the sad experience there showed to be a favorable soil for the propagation of the disease, remained immune until the 23d of August.

Procida, which would have had a case of cholera on the 21st of July, remained free of the disease until the 22d of September.

What greater proof could we have of the retarding influence exercised by the defense organized at the frontiers?

This much may be asserted, that many communes remained free of the disease through



the efficiency of the quarantine established. Indeed, we find that persons belonging to the communes of Acqui, Cosenza, Vicenza, Positano, Pamparate, Gareggio, Pomaranci, Campobasso, Diamante, Bagni di Lucca, Taggia, Fenestrelle, Rocaforte, Pontedera, Rapallo, Bonasola, Viggiano, Piacenza, attacked by cholera, are treated in the lazarettos at the frontier, and no case of cholera afflicted those communes—they remained entirely free during the course of the epidemic.

In view of these facts, the truth of which no one can invalidate, we are forced to admit *that the measures of quarantine adopted by the Italian Government retarded the development of epidemic foci in the Kingdom and entirely protected many communes from the invasion of the disease.*

Quarantine, however useful it may have been, from the stand-point of experience does not possess the power of really saving Italy from an invasion of cholera. Basing themselves upon this dolorous conclusion, impracticable observers and the opponents of the system proclaim the necessity of abandoning these means of defense.

Another course appears more logical to us, that of seeking, if possible, to discover the reasons why quarantines imperfectly meet their requirements, in order to improve the enforcement of them in the future.

On account of the assertion that quarantines are useless, and can not be otherwise, because they were eluded by every one who desired to do so, I have collected data for the purpose of investigating how the morbid germs first reached the various epidemic foci.

I have, however, not found any of the first cases of cholera in the various Italian communes in those persons proceeding from France who had escaped quarantine observation.

On the contrary, I have found that the first persons attacked are individuals who have undergone quarantine, or have had communication with persons proceeding from infected localities who were likewise subject to quarantine observation.

In considering a subject of such importance as this it is desirable to enter into a minute and exact analysis of the facts.

The epidemic foci due to direct importation of the disease from France are those of Garfagnana, in the province of Massa; Piemonte, Berceto, in the province of Parma; Cairo Montenotte, and Spezia, in the province of Genoa, and finally those of the south of Italy.

We learn exactly how the infection arrived at these points:

In Garfagnana none of the first attacks were among those returned from France, yet among the inhabitants there were more than a thousand workmen who had returned from Toulon and Marseilles soon after the outbreak of the epidemic there. They underwent the prescribed quarantine, except 10, who arrived in the commune of Piazza al Serchio, having returned to their country before the establishment of quarantine. Evidently, however, the disease was not brought among the inhabitants of Garfagnana by a sick person who had escaped observation at the frontier, but by healthy persons who for the greater part stopped in quarantine and who imported the morbid germs with their effects, notwithstanding the quarantine which they had undergone.

In Piemonte the epidemic commenced with Pancalieri and neighboring communes in the province of Turin, whence the disease radiated to the neighboring parts of the province of Cuneo.

From the above-cited facts concerning the first cases in which the epidemic was traced to its origin it is found that none of these were immigrants from France, yet in these communes we find, nevertheless, a number of immigrants who evidently imported the disease, being themselves free from attack.

At Berceto, in the province of Parma, the first attacked was a certain Giaretti Pietro, coming from Marseilles, who, after having undergone quarantine at Varignana, returned home presenting the symptoms of the disease.

He recovered, but after him a certain Beltrami Martino was attacked and died, who had had domestic relations with the former during his sickness.

There were 62 other cases following these first two. At Cairo Montenotte, more particularly in two portions of this commune (Vignaroli and Bellini), none of the attacks were among

those returned from France. We find, on the contrary, that the first case is met with in the person of an inhabitant, a certain Fransino Luigi, who had communication with a relative returned from Toulon, where he had performed the duties of a nurse. Arrived home after having undergone the prescribed quarantine at Pian di Latte, he brought into the household some clothing which appeared to have belonged to cholera patients and gave them to his relative, who began the epidemic, and from whom more than two-thirds of the inhabitants of that locality were infected.

At Spezia none of the attacks were among those returned from infected localities beyond the frontier, but in order to understand the origin of the disease (we shall occupy ourselves with this in detail on another occasion) we must admit that it was due to indirect importation and by means of persons who returned in good health.

The epidemic foci of the south (1884) trace their origin from the inhabitants of Isernia, in the province of Campobasso, where the disease appeared, not in persons returned from France, but in persons who had communication with many persons returned from infected localities and who had all undergone quarantine in some of the lazarettos.

Therefore it is evident that the recent epidemics of cholera were lighted up in Italy, not by sick persons who had escaped quarantine observation, but, on the contrary, by means of healthy individuals who imported the disease either directly or by their effects, notwithstanding the quarantine which they had undergone.

To him who reasons carelessly it might seem that from the above experience the most patent proof may be deduced of the uselessness of the measures of quarantine adopted. And thus it would not be difficult to find one who, making use of the facile and ancient "*proctor hoc*," might say that the quarantine stations had in fact been the origin and cause of infection.

We will pass by this last objection; it is too puerile to stop and examine. Let us, however, consider the first for an instant. A little reflection is sufficient to convince us that arguments of this kind are as ungrounded as they are specious.

All of our data demonstrate the following fact: That it was precisely the quarantine at the frontiers which the infection could not elude.

It did penetrate through the quarantine, and the fact suffices for the estimation of the potentiality of quarantine as opposing a serious barrier to the progress of the infection. What if it does not offer a complete barrier, the method of defense should not be condemned absolutely, but on the contrary we should consider how to modify it.

And here I would recall to mind what I have said already, that the disease is imported either by persons who, healthy themselves, carry with them their clothing contaminated with infectious material, or by persons who, notwithstanding the quarantine undergone, fall sick of the disease after arrival at their homes. From this it ought, therefore, logically to be deduced that if the effects of these emigrants had not been introduced into the country the germs of the disease would not have arrived there, and it was not difficult to accomplish this end.

If the effects of those coming from infected localities were resolutely destroyed by fire, and if, after washing and disinfection of their persons, the emigrants had been reclothed with uncontaminated garments, the importation of the morbid germs in many of the localities, and especially in the south of Italy, would have been impossible.

With respect to those who, after having undergone quarantine, became sick with cholera after having departed from the lazarettos at the frontier, it might seem that a greater extension of the period of quarantine might have been capable of preventing the entrance of the infectious material. Certain it is, in reality, if they had been retained in the lazarettos a few days longer they would have fallen sick there. But if we bear in mind the teachings of experience, which are confirmed to-day by the experimental studies, that is, that ordinarily the period of incubation of cholera is not greater than two or three days, we ought to admit that the opinion of Baccelli is well founded, viz, that the infection of those unfortunate localities does not take place in a direct manner from the original foci, but, in fact, by disease germs imported with the effects, and therefore by subsequent contact with these same effects. We are therefore treating of a mode of infection which, if we should resolutely destroy all the effects of the emigrants, we would in all probability be able to escape.



For him who desires to examine the question with impartiality and independence of judgment, it may be assumed from the facts thus far enumerated that the measures of quarantine adopted by the Government succeeded in retarding the formation of epidemic foci in Italy, preserved many communes from the invasion, and perhaps might have preserved the whole country, or almost all of it, if the measures had been applied in a different manner.

It is certain that an examination of the statistics furnished by the lazarettos proves that the measures of quarantine enforced along the Austrian and the Swiss frontiers were quite unnecessary. We see, in fact, that there was no case of cholera in the lazaretto established along those frontiers, neither could the disease easily have penetrated into Italy by means of persons coming from that direction. This fact has its explanation and its proof in another one, which is furnished by the examination of the table of statistics deduced from the already mentioned reports. By these statistics it is proven that those attacked with the disease in the lazarettos were altogether persons belonging to the third class: that is, persons in unfortunate social position who were maintained in the lazarettos at the expense of the state—those who, by their unfortunate financial conditions, are obliged to preserve effects which, although infected, represent all which they possess. And, on the other hand, they also prove the exactness of what we have also previously asserted, namely that people in easy circumstances who embark upon a long and expensive journey in order to cross a more remote frontier in the hope of evading the rigors of the quarantine are not to be feared.

Resuming, therefore, that which experience has taught us concerning the measures of external defense, the following deductions seem to be warranted:

That measures of quarantine may be useful at the frontiers adjoining an infected nation, and that the nearer the focus of disease is to the frontier the more necessary are these measures.

That the efficacy of quarantine depends more upon the manner in which it is enforced than upon its duration, and that consequently a quarantine of forty-eight hours (which, added to the time consumed in arriving at the frontier, about corresponds to the ordinary incubation of the disease) ought to be sufficient for performing careful disinfection, or, better still, the destruction of the effects of the immigrants and the substitution of others for them;

That it may be very well to omit the quarantine at the frontiers which are remote from the foreign foci of infection;

That of all the quarantine restrictions certainly the best of all is that which has been already partly enforced by the Italian Government, and which consists in the collection of immigrants aboard of ships at the point of destination and subjecting them to quarantine in a maritime lazaretto or on some small island which is near their point of destination.

V.—Let us examine now what has been done for the internal defense.

When the infection penetrated to some parts of the country sanitary cordons were established in several localities with diverse results. Some of them did not at all correspond to expectations, the disease spreading in spite of them to adjoining communes, as was the case in the province of Turin with the cordons of Pancalieri, Villafranca, and Osasio. Others, on the contrary, met perfectly all the expectations of the authorities.

At Sesame (Alessandria), Alfedena (Aquila), Gaeta (Caserta), Pietraterrazzana (Chieti), Paterano (Cosenza), Cairo Montenotte, and Spezia (Genova), Seborga (Porto Maurizio), Coperchia and Teggiano (Salerno), after the establishment of the cordons the infection did not spread from the foci or from the cordons, but in another manner.

Perhaps, however, the believers in the localistic doctrine of Pettenkofer will object that if the disease did not spread beyond the cordons it was because the soil was not in a favorable condition for its reproduction. For us who hold the doctrine of Pettenkofer as an exaggeration and a result of hypothetical deductions this objection can certainly have no weight. Among the occurrences of the last epidemic there were two examples wherein the objections of the localists could have no application. These two examples relate to the cordons established in the provinces of Massa and Parma.

The province of Massa consists of two parts, that called Massa and another named Garfagnana. The disease began almost simultaneously in several communes of Garfagnana, first in that of Piazza al Serchio. Communal cordons were attempted at the beginning, but, seeing

that already the infection had penetrated the adjacent country, the whole region was isolated within a cordon. None of the communes of the other portion of this province—that which from its capital is called Massa—were attacked. But the large focus then broke out in Spezia. During the first two days, before this unfortunate city was isolated, many persons fled. And now we see the disease breaking out at Tordinovo, where the first person attacked is an individual coming from Spezia; at Aula, where the first victim is a refugee from Spezia, at Calice al Cornovaglio, where likewise the first attacked is a refugee from Spezia; at Casola, in Lunigiana and at Fivizzano, and in these two localities it is the fugitives from Spezia who import the disease.

Although the communes already enumerated belong altogether to the neighborhood of Massa, where, moreover, conditions favorable to the development of the disease exist, although whilst infective material did not arrive from Garfagnana, which was closed in time, they remained at first immune, to pay afterwards a fatal tribute as soon as infected persons arrive there from a focus which remains uninclosed.

At Berceto, in the province of Parma, the disease broke out, being imported directly from France. A sanitary cordon was established. From Berceto the disease did not radiate to the neighboring communes, but afterwards refugees from Spezia arrived in the province, and then the disease broke out in several points of it. There was evidently a favorable soil for the development of the germs anterior to this time. The isolation in which Berceto was placed saved those communes, which afterwards were attacked as soon as the infection arrived there by another way. Therefore, when measures are enforced in time, and when the topographical conditions permit it, it must be admitted that isolation of centers of infection by means of sanitary cordons may work advantageously to the adjoining communes. And the cordon of Spezia, as we shall relate in detail in the proper place, has demonstrated that isolation, although tardily adopted, can be at least partially, although not absolutely, successful. If the communes of the provinces of Massa, Parma, Modena, and Reggio may be cited in which the disease was brought from Spezia before the isolation of the latter, on the other hand, there may be mentioned the case of all the communes of the Riviera, from Spezia to Genoa, which remained immune, an immunity certainly due to the fortunate circumstances of not having succored infected refugees during the time when Spezia was open, and of having been, through precautions afterwards taken, preserved from this unfortunate possibility. Whoever is acquainted with the miserable hygienic condition of those communes will readily comprehend how easy reproduction and propagation of the morbid germs would be there should they once arrive. The experience of places under similar unfortunate circumstances is sufficient to convince one of this.

It has been remarked that the objection raised against sanitary cordons is that they may be the cause of diffusion of the disease among the military employed in accomplishing the isolation.

I endeavored to discover the truth with respect to this matter. From data furnished me, and which I have reason to believe exact, there were eleven deaths to be deplored among the cordons: One soldier who was a member of the cordon of Porretta, five in Garfagnana, three in Berceto, one in Seborgo, one in Pelezzano (Salerno). It is certainly painful to record the death of these victims; but I would add the reflection that if the soldiers employed in this duty had maintained their habitual residence in the infected centers they would have paid, it is presumable, a larger tribute to the disease. Another and a much more serious matter with respect to sanitary cordons can not be estimated by us from positive data; it is that which relates to the persons inclosed within the cordons. It is objected that by impeding emigration from the infected locality individuals are attacked by the disease who by fleeing might escape. We have, as we say, no numerical data from which to assert that this charge has had no special confirmation in our country; on the contrary we have reason to believe it well founded, especially as respects the cordon of Spezia. It must be admitted, although it can not be demonstrated by precise figures, that many of those dead from cholera might have been saved by abandoning the infected place. True it is, however, that perhaps the greater part of those unfortunates instead of fleeing might not have been able to abandon their usual homes on



account of their unfortunate financial circumstances, yet it can not be conscientiously denied that the cordon may have contributed towards rendering the epidemic more intense. From these facts it should follow that the application of sanitary cordons on the one hand must be reserved to localities in which alone it is possible to seriously and efficiently enforce them; on the other hand, as we have already said, there ought to be provision by appropriate measures that if any one desires to abandon the infected locality he may be able to do so without danger to the health of the surrounding country. Thus at Seborgo, in the province of Porto Maurizio, where there was an epidemic focus, the population was made to abandon their habitations and was isolated in a salubrious site somewhat distant from the town. This measure sufficed to prevent subsequent manifestations of the disease among these people. A similar measure was successfully adopted for the inhabitants of the invaded districts of the commune of Cairo Montenotte. *En résumé*, therefore, it can be asserted that experience has demonstrated the existence of cases in which isolation of the infected locality has been useful in limiting the diffusion of the disease, and that by the enforcement of opportune measures it is possible to avoid the grave consequences which are complained of by the inhabitants of the isolated locality.

Besides sanitary cordons there were other measures looking to the limitation of the diffusion of the disease which were enforced with good results. These were:

- (1) Isolation of the sick into groups of patients when this could be done;
- (2) The practice of disinfection whenever the first cases appeared;
- (3) The surveillance of travelers, and medical inspection at the points of departure from the infected locality, in order to prevent persons from traveling who already present the first symptoms of cholera; and the same measure should be enforced at the station of arrival, in order that the germs of the disease may not enter healthy communes;
- (4) Limitation of communications by railway, in order that contact between the infected and the healthy centers may be less frequent;
- (5) The prohibition of the circulation through the country of personal effects, of soiled clothing, and of rags.

All of these measures gave satisfactory and excellent results.

Among the 801 communes in which the disease made some headway, only 32 had more than 50 cases. Of the remainder, there were 245 with 1 case, 274 with 2 to 5 cases, 117 with 6 to 10 cases, 83 with 11 to 20 cases, and 50 with 21 to 50 cases.

Besides these efficacious measures, now and then some useless ones were enforced. Among these I would mention fumigations of travelers. They are powerless to destroy the infectious germs which may by chance already exist within the organism, or to destroy those which may exist within the clothing of the travelers.

In view of these facts, when we look at the action of the Government during the last invasion of cholera and attempt to criticise it with an impartial mind, free from bias, we must admit that it was beneficial and that it saved our country from many misfortunes.

This experiment performed by the Italian Government demonstrated that the authorities can really exercise great influence in limiting the propagation of a contagious disease. And although science has not indicated to us in a precise manner all the ways by which the choleraic germ is propagated, a government would be culpable respecting the protection of the public if it should refuse to enforce the measures which, although still partly empirical, often either entirely or at least partially meet the requirements.

We are treating here, it must not be forgotten, of measures which affect very many interests, which often violate personal liberty. Complaints are therefore natural and inevitable, but a physician does not inquire if a measure for the preservation of the public interferes more or less with the liberty of the citizens, if it weighs more or less heavily upon the State, if it offends private or public interests; on the contrary, the physician solely inquires if and how a measure for the protection of the public may meet the humanitarian and economical ends for which it is chosen. Nevertheless, from the data which we have collected and studied we believe we can conscientiously assert, as we have already done, that the measures taken were useful. Not all of them were necessary; some of them may even be denounced as absurd, others as useless; but looked at in their entirety I repeat that they were advantageous.

It seems to us, therefore, absurd to argue against the capabilities of a thoroughly equipped maritime quarantine, strictly administered, from the historic failures of those establishments which with respect to plant, equipment, and direction have been obviously deficient in the essential requirements of a modern quarantine.

The second objection is always a serious one for a people extensively engaged in maritime trade. But it is met, we think, by a due consideration in the light of present knowledge of the *wide and essential difference* between the requirements for the proper treatment respectively of the ship's *cargo* and of the ship's *inhabitants*. It is the ship's *inhabitants*, with their *personal effects*, who almost invariably *introduce the infectious germs* into the country; *the merchandise rarely or never conveys the contagion*. Indeed, so far as cholera, small-pox, and scarlet fever are concerned it is only cargoes of rags that may be looked upon with suspicion as possibly capable of transporting the germs of disease from Europe to America. With this possible exception it is not only unnecessary, but there is absolutely no excuse in the treatment of ships with these diseases aboard to detain the cargoes in quarantine for a prolonged period. With adequate facilities at hand the proper disinfection of the ship need not require her detention or that of the cargo longer than twenty-four hours an impediment to trade too insignificant to be taken into account when the paramount interests of the public health are considered.

With reference to the detention at quarantine of those of the ship's inhabitants who are well, it need be prolonged but little beyond the period of incubation of the particular disease against which the quarantine is directed. The inconvenience of this detention the traveling and immigrant classes alone suffer, the commercial interests of the general public being undisturbed thereby. In the great majority of instances it is among the immigrants only that actual cases of disease exist; and when we consider the advantages which the immigrant is about to receive the necessary detention is but a small sacrifice for him to make for the benefit of the people among whom he seeks a home.

## SECTION 2.

### NATIONAL CONTROL OF MARITIME QUARANTINE A NECESSITY.

In view of the foregoing considerations I would uphold the following propositions:\*

A.—*The present methods of independent quarantine provided and regulated by sea-board States or cities are essentially defective and insufficient for the exclusion from the United States of the diseases against which quarantine is directed.*

The truth embodied in this statement is abundantly established by the report of a committee of the College of Physicians of Philadelphia, 1888, in regard to the three ports it inspected (New York, Philadelphia and Baltimore) during the time of prevalence of cholera at the quarantine station of New York in the autumn of 1887. It is fully borne out in regard to the other quarantine stations between the St. Lawrence River and the Rio Grande by the elaborate official report Dr. John H. Rauch, secretary of the Illinois State Board of Health, made to that body in 1886.

The defects of local quarantine stations arrange themselves in two principal groups: (1) Inadequacy of establishment. (2) Faults of administration.

(1) With regard to the establishment—which term is here used to include the accommodations for the temporary housing and care of immigrants and travelers not sick, adequate hospital accommodations for the sick, appliances for disinfection, and the necessary medical, nurse, police, and other attendants for the care of both of these groups of individuals—only

\* Since the preparation of this section and in the incorporation and publication (1888) of the greater part of it in an address issued by a committee of the College of Physicians of Philadelphia, of which the writer was one, the national Congress has passed an act with the approval of the President which looks to the establishment of national control of quarantine; and the legislature of the State of New York has greatly modified and reformed the quarantine laws relating to the management and administration of the quarantine station in the port of New York.



four of the many stations upon the Atlantic and Gulf coast may lay claim to anything like adequate provision. These are Grosse Isle quarantine station on the St. Lawrence River below Quebec, the Boston quarantine station on Galop's Island, that in the New York harbor, and those in the Mississippi River below New Orleans.

Of these four it may be said, first, that the very excellent establishment at Grosse Isle is practically useless as a safeguard against the importation of disease, in view of the fact stated in the report of Dr. Rauch, that during the quarantine season up to October 9, 1885, only thirty-two vessels out of a total of four hundred and twenty arrivals had stopped at this station for examination; second, that no mention is made in Dr. Rauch's description of the quarantine station at Boston of any provision for the housing and care of travelers and immigrants not sick; third, that in the last-named particular, as well as in several other respects, the quarantine station at New York, hitherto regarded as fully adequate to the requirements of that great port of entry, shows serious defects. According to the official description by Dr. Joseph Holt, president of the State Board of Health of Louisiana, it would appear that the quarantine station at the mouth of the Mississippi is in respect of establishment fully up to the requirements of modern science. Of the intervening stations it is scarcely necessary to speak. Certainly as regards the prevention of cholera, and to a less extent also of yellow fever, the greater number of them constitute quarantine stations simply in name.

(2) When we come to consider faults of administration it is obvious that it is impossible to discover their nature or extent during times of quarantine inactivity—that is to say, during those fortunately more or less prolonged periods in which the absence of disease upon incoming ships narrows the duties of the quarantine officials down to the simple inspection necessary to establish that fact. At such times we have therefore at present no criterion by which to judge of the efficiency of the quarantine administration at the greater number of the stations. The fact already mentioned with reference to the quarantine station at Grosse Isle, that during the quarantine season of 1885, up to October 9, only thirty-two vessels out of the total four hundred and twenty were examined, indicates defects in administration at that station so glaring as to require no further comment.

Faults of administration equally serious although of a different kind were shown by the above cited report of the committee already mentioned to have recently existed at the quarantine station in the lower bay of New York Harbor at a time when cholera actually existed in the hospital and was from day to day finding new victims among more than five hundred Italian immigrants detained at the quarantine of observation on Hoffman Island. It is only necessary to emphasize this statement by calling attention to the following facts brought to light by the investigations of that committee: First, the absence of resident medical officers both at the hospital on Swinburne Island and at the quarantine of detention on Hoffman Island; second, the absence of anything like an adequate sanitary police force on the latter island; third, the absence of any effort to separate the well, detained on Hoffman Island, into small groups, and the lack of any proper daily systematic inspection, such as would enable the authorities promptly to discover and isolate new cases of cholera; fourth, the unreasonable detention for a period of nearly two months of more than five hundred immigrants not sick under circumstances of great hardship, exposure, and deprivation, a fact which, in view of the present state of knowledge in regard to the nature and mode of transmission of the infecting principle of cholera, in itself bears overwhelming testimony to faulty administration. And this was the situation after cholera had continued to prevail in countries the ports of which were in constant, direct communication with New York for a period of four years, and after the entire public press of the United States had persistently called attention to the ever-present danger of its reaching our shores. When the state of affairs actually existing at the New York quarantine during the presence of cholera there in the autumn of 1887 is compared with the impressions of Dr. John H. Rauch concerning the completeness of the quarantine at that port in 1885, as expressed in his own words, the difficulty of justly estimating the real efficiency of any such establishment by inspections made during seasons of comparative quarantine inactivity becomes apparent. Dr. Rauch thus sums up: "With reference to the exclusion of cholera and small-pox, the quarantine plant and facilities of the port of New York are unrivaled,

the printed regulations judicious, and with proper vigilance the service should suffice to prevent either of these diseases from obtaining access to the country through this avenue."

B.—*It is impossible adequately to protect the public health of the country against the importation of epidemic diseases by independent local maritime quarantine establishments.*

(1) The history of epidemic diseases in this country serves to establish the truth of this proposition. Every epidemic of cholera, typhus, or yellow fever and several important epidemics of small-pox have been directly imported in spite of existing quarantine regulations.

(2) There is always great difficulty in obtaining sufficient appropriations of public money to defray the expenses of the necessary quarantine establishments and their proper maintenance. It is only possible during periods of threatened invasion to procure the considerable sums of money necessary for these purposes, whilst in the interim the money expended is greatly inadequate, though large amounts are constantly needed. When the invader is at our gates it is often impossible to plan, construct, or repair, and properly equip and garrison an efficient line of defenses.

(3) Rival political and commercial interests are inimical to the perfect protection of the general public of the whole United States by independent and local quarantines.

The port of New York, through which three-fourths of the imports and immigrants enter the country, is in the following peculiar situation with respect to the relations of local health boards: By the health laws of the State and of the municipality of New York the principal quarantine officer is a member *ex officio* of the municipal board of health of the city of New York and of the State board of health, and he is also a member of the quarantine commission. Neither the State nor the municipal boards have therefore a voice in the direction of quarantine. Each of these three bodies consists of a very limited number of members, and each is also entirely independent of any supervision or control by the others. Not only does this anomalous independence exist in accordance with the provisions of law, but there is undoubted evidence of an indisposition of the city board of health to inquire in any manner into the management of quarantine at the port, that organization not being officially under its care.

In a letter dated November 4, 1887, replying to an official communication from the mayor of New York, making inquiries concerning the dangers to which that city was exposed by reason of the existence of cholera at the quarantine station of the port, and the means of preventing its spread to the city, the president of the municipal board of health, after detailing the provisions which had been made for the prompt isolation and treatment of cases of cholera which might develop in the city, explicitly denies official knowledge of the condition of affairs at the quarantine, and further states that he would regard it as unbecoming for him to discuss it; this notwithstanding the fact that the quarantine officer is a member of that same board.

(4) The last statement illustrates one of the most serious dangers to which the general public is exposed through local maritime quarantine organizations, namely, the possibility of bodies of immigrants with infected baggage being transferred directly from the quarantine station to distant inland communities by rapid railroad journeys, without any prolonged sojourn or without any adequate inspection or precautions being taken by the authorities of the sea-board cities through which they pass. In point of fact this danger was realized in regard to cholera in 1873, when epidemic outbreaks of that disease occurred in Ohio, Minnesota, and Dakota, which were "caused by cholera poison packed up in the household effects of emigrants from Holland, Sweden, and Russia, respectively. *These emigrants sailed from healthy ports in healthy vessels and were subjected to the usual sanitary requirements of the period. They passed through New York and the intermediate territory without injury to the public health; but when their infected goods were unpacked in the interior of the continent they liberated the poison which gave rise to the local outbreaks.*" [Report of Dr. Rauch.]

(5) It is but natural that municipal organizations should, in looking after their own interests, pay little regard to the welfare of distant communities.

In this connection may be noted the indisposition and failure on the part of local quarantine officers to notify the authorities interested of the arrival of emigrants from infected localities. Notwithstanding the frequent paramount interest of inland communities in the efficiency of the establishment and administration of quarantine at the sea-board the local authorities of



the latter frequently evince an unreasonable jealousy of any sort of investigation or suggestion looking to the general welfare.

(6) In the absence of any general regulation or supervision, local quarantine measures must in the nature of things be exercised with varying degrees of efficiency; the most complete establishment and perfect administration at a few ports might therefore fail to protect the country if defective or inadequate measures of quarantine were practiced elsewhere.

Yet every one of the 65,000,000 inhabitants of the United States has personal interest in the condition and efficiency of the quarantine establishment at every one of our ports. Why, then, should the direction, expense, and responsibility of a system of common defense against the inroads of foreign diseases, any more than against invasions of foreign foes, be assumed and borne by those municipalities or States which happen to have a maritime location? Why should the vast majority, located inland, be allowed to shift their responsibilities and obligations or be denied a voice in the direction of affairs which so greatly concern them? The protection of the public health by maritime quarantine is a matter which interests not merely a narrow belt of sea-coast; it seriously concerns the whole of the vast territory between our shores.

C.—*A national system of maritime quarantine is necessary.*

(1) It is only by this means that the necessary protection against the importation of epidemic diseases in all our ports can be continuously secured.

(2) It is the only practical means by which uniformity of establishment and administration, regard being had to the modifications made necessary by difference of latitude and other circumstances, can be assured. Such necessary uniformity can be obtained by no other arrangement, for the reason that the National Government is alone able to defray the expense of complete quarantine establishments at every port, according to the requirement of each and without regard to the revenue derived from the shipping of any.

(3) The benefits of quarantine inure to the welfare of the whole country; therefore, it is just that money should be as freely expended when necessary at one port as at another, without respect to their relative commercial importance or to the amount of revenue collected in the shape of boarding and inspection fees, etc. It is manifestly unfair that the seaboard cities and States should, as at present, be obliged to bear the entire expense of quarantine establishments whose most important function should be the protection of the inhabitants of every region of the vast territory of the United States.

(4) A national quarantine properly administered and conducted by trained officials accustomed to deal with contagious and infectious diseases would tend to prevent panic, to allay undue anxiety, and to favor a reasonable sense of security.

(5) Experience has shown that much needless alarm, as well as preventable danger, arises upon the appearance of an unfamiliar epidemic disease at quarantine stations, as when cholera has shown itself at New Orleans or New York, or yellow fever at Philadelphia or Boston. A national quarantine would go far to do away with the necessity for vexatious temporary interstate quarantines, which so seriously disturb inland trade.

(6) A national quarantine system, directed in such a manner as to fully meet the requirements of existing sanitary knowledge, would not adversely disturb any commercial interest. It would, on the contrary, do away with many of the embarrassments incident to maladministration of existing local regulations. For example, the healthy passengers of the Italian steam-ship *Alesia* were *detained* at quarantine in New York harbor for a period of *fifty-eight days*, while under an efficient system uninfluenced by needless fears those of them who were free from disease *could have been safely* liberated in ten days at furthest.

(7) A national quarantine would not necessarily supersede any existing arrangements regarded as expedient by local authorities. It should constitute an outer line of defense under exclusive control of the National Government, and it should be conducted wholly without cost to shipping, and would thus work no additional pecuniary hardship, even if the present fees were to be still exacted by the local authorities.

(8) The ability of the National Government by an existing act of Congress to come to the aid of local quarantine authorities in answer to the appeal of the executive of any State

in time of grave danger implies a function of very narrow scope and uncertain application. Appeals of this kind are apt to be deferred until the emergency is extreme, and the aid obtained from the Government is therefore likely to be rendered too late to accomplish its most important purpose, namely, the prevention of an invasion.

D.—*A national organization would secure advantages not attainable by independent local quarantine establishments however complete.*

Among many other advantages the following may be enumerated:

(1) Suitably arranged and commodious buildings provided with necessary furniture and appliances at all ports.

(2) An efficient corps of trained officials and assistants always on duty.

(3) The practicability of the concentration of force, money, and attention at any threatened port without loss of time.

(4) Officials under control of the National Government and free from local political and commercial influences.

(5) The objects of quarantine would be furthered by full and reliable consular reports and sanitary inspection of emigrants at ports of embarkation, functions properly belonging to officials of the General Government.

The organization of a national maritime quarantine system in the United States should require:

(1) That the whole matter be placed under an appropriate department of the General Government.

(2) A central bureau of control established at Washington.

(3) A sufficient corps of medical officers and assistants, with nurses, sanitary police, laundrymen, engineers, and officers and crews for boarding tugs, organized at every station. *Among the requirements for the medical service should be a speaking knowledge of at least two modern European languages besides English.* In view of the constant and systematic attempts to falsify the ship's logs for the purpose of concealing the existence during the voyage of infectious disease, the health officers should be able when necessary to go among the passengers and *themselves* closely question them, without the mediation of an interpreter. The establishment of a school and laboratories for sanitary instruction and research in connection with this service would be an advantage. In addition to the men on duty at the respective stations there should be a sufficient number of medical and other officials fully trained in quarantine duties and familiar with contagious diseases, unattached and available for immediate auxiliary service at any threatened port.

(4) The erection of necessary hospital and other buildings, wharves, disinfecting apparatus, wash-houses, latrines, etc., in suitable localities, when possible upon islands at or near the entrances to harbors, and at some distance from the main channel.

(5) These stations must be organized and fully equipped at every port of entry of the coast in such a way as to meet the requirements of each port in the measure of its commerce and immigration and the especial diseases to which it is most exposed.

(6) The cost of the establishment and maintenance of the national maritime quarantine should be provided for by appropriation from the National Treasury, and not from fees exacted from vessels.

The danger from immigrants would not be entirely banished, however, though the quarantine of the coast of the United States were perfect, for the way through the British provinces would still be open to these travelers. In the absence of efficient quarantine inspection in the St. Lawrence River, the attempt thoroughly to protect ourselves from importations of epidemics would necessitate the doubtful and difficult expedient of a land quarantine along our northern frontier. The more efficient plan would be to have the same precautions taken at the ports in the British provinces as should be practiced at those in the United States; but this course could only be assured through treaty, which our local authorities are not competent to make.

It appears that our Canadian neighbors have already evinced their desire for uniform quarantine laws for the two Governments. The provincial board of health of Montreal,



recognizing a community of interest in the question of maritime quarantine, deemed the presence of the Canadian fish commissioners in Washington opportune for the adoption of resolutions requesting them to urge upon the American authorities "the necessity of establishing uniform quarantine regulations for both countries." In connection with an efficient system of national quarantine a harmony in the provisions of law in the United States and in Canada seems indispensable for the full protection of our extensive northern frontier, and our National Government should be strongly urged to respond actively to the expressed wishes of the Canadian authorities relating to such an important matter of common interest.

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### SECTION 3.

#### GENERAL MEASURES OF PREVENTION.

Measures of prevention, to give the greatest possible guaranty of success in extinguishing an incipient epidemic of cholera, should, in the first place, be based upon the most exact knowledge we possess of the cause, mode of attack, and manner of spread of the disease; and in the second place, these measures should be intelligently, promptly, thoroughly, and rigidly enforced.

What are the considerations involved in the first category? Probably nine-tenths of intelligent and experienced physicians all over the world, even including those of India, have for years admitted that there is most convincing proof that the active cause of the disease is a specific, material, living entity, of extremely minute size, endowed with the power of self-propagation and of exceedingly rapid multiplication in enormous numbers; that among animals it naturally attacks man alone, assailing him only by way of the intestinal canal; that the evacuations from the bowels contain the active cause of the disease, and that when this agent in any manner—as through drinking water, milk, food, or the handling or washing of contaminated personal effects, etc.—reaches the intestines of another susceptible person the disease may be thereby transmitted from the sick to the healthy; that the active agent exists in the dejecta of the lightest and most imperceptible no less than the severest and most deadly forms of the disease, and is known to be transportable from place to place through the movements of man and his personal effects.

Proceeding from this basis, logical deduction and common experience alike demonstrate the absolute necessity and efficiency of such measures of prevention as the following:

(a) Speedy recognition and isolation of the sick; their proper treatment; absolute and rapid destruction of the infectious agent of the disease, not only in the dejecta and vomit, but also in clothing, bedding, and in or upon whatever else it finds a resting-place.

(b) The convalescents should remain isolated from the healthy so long as their stools possibly contain any of the infecting agent, say for ten to fourteen days after the commencement of the attack; before mingling again with the well they should be well washed and immersed in a disinfecting-bath, and afterward be clothed from the skin outward with perfectly clean vestments which can not possibly contain any of the infectious material.

(c) The dead should be well wrapped in a cloth thoroughly saturated in a solution of corrosive sublimate, 1 to 500, and without delay, cortège, or lengthy ceremonial buried near the place of death in a deep grave, remote as possible from water which is liable under any circumstances be used for drinking, washing, culinary, or other domestic purposes. (Cremation, of course, is by far the safest way of disposing of cholera cadavers.)

(d) Those handling the sick or the dead should be careful to disinfect their hands and soiled clothing at once, and especially before touching articles of food, drinking or culinary vessels.

(e) In the case of maritime quarantine the well should be disembarked and placed under observation in quarters spacious enough to avoid crowding, and so well appointed and furnished that none will suffer real hardships.

(f) Once having reached the quarantine station, those under observation should be separated in groups of not more than twelve to twenty-four, and the various groups should under no pretext intermingle; the quarters for each group should afford stationary lavatories and water-closets in perfect working condition adequate to the needs of the individuals constituting the group, and supplied with proper means of disinfection; there should be a bed raised above the floor, proper coverings, and a chair for each member of the group, each person being required to use only his own bed; there should be a common table of sufficient size to seat around it all the members of the group, who should be served their meals from a central kitchen, and with table furniture belonging to the station and cleaned by the common kitchen scullions.

(g) Drinking water free from possible contamination and of the best quality should be distributed through pipes under constant pressure in the quarters of each group as it is needed, and in such a manner that it is received in drinking-cups only; there should be no water-buckets or other large vessels in which handkerchiefs, small vestments, children's diapers, etc., can be washed by the members of any group.

(h) Immediately after being separated into groups in their respective quarters every person under observation should be obliged to strip and get into a bath (a disinfecting one is preferable), and afterward be clothed with fresh, clean vestments from the skin outward. Every article of clothing previously worn should be promptly taken away and properly disinfected without delay.

(i) Then all of the personal effects should be at once removed to a separate building, washed—if possible—and thoroughly disinfected, or, if necessary, destroyed. After disinfection they should be temporarily returned to the members of groups when occasion requires a further change of clothing.

(k) Under no circumstances whatever should washing of clothing by those under observation be permitted. All used clothing should be first thoroughly disinfected (by boiling when possible), and then should be cleansed, the disinfection and washing being done by a sufficiently trained and absolutely reliable corps of employees supplied with adequate appliances.

(l) All those under observation should be mustered in their own quarters and be subjected to a close medical inspection *while on their feet* at least twice every day, in order to discover and isolate as soon as possible new cases which may develop; and of course the clothing and bedding of these new cases should be treated without delay in the manner already mentioned. In the mean time a watch should be set over the water-closets for the purpose of discovering cases of diarrhœa, and when discovered such cases should be temporarily separated from the rest; they should receive judicious medical attention at once, and precautions should be taken as if they were undoubted, but mild, cases of cholera.

(m) The quarters should be kept thoroughly clean, and every surface upon which infectious material could possibly be deposited, including the floors, should be washed with a strong disinfectant twice daily, and oftener when necessary; evacuations from the bowels should be passed into a strong disinfectant; the hopper of the closet should then be flushed and finally drenched with a quantity of the same disinfectant.

(n) For the proper attention to the sick there should be two or more competent and experienced physicians, assisted by a sufficient corps of intelligent and efficient nurses, with hours of duty so arranged that a physician with a sufficient number of nurses be in constant attendance in the wards of the hospital.

(o) For the prompt recognition and separation of new cases, their temporary medical attention, the proper treatment of discovered cases of diarrhœa or cholera and of other maladies, and the immediate correction of every unsanitary practice or condition by constant, vigilant, and intelligent supervision, there should be at least two or more competent and experienced physicians, with hours of service so arranged that a physician is on duty night and day among those under observation; and he should have subject to his order at any and every moment a sufficient and efficient corps of nurses and laborers to carry out properly and promptly his directions.

(p) In order to prevent the intermingling of the various groups, to enforce obedience and order, and to make it absolutely impossible for the quarantined and their personal effects to



have any communication with the exterior, a well organized and sufficiently large police corps should patrol the borders of the stations and the buildings day and night.

(q) Any group among whom there has developed no new cases of cholera, or of choleraic diarrhoea, during the preceding six or eight days, may be regarded as harmless, and allowed to leave quarantine after each one is finally immersed in a disinfecting bath, and re clothed with clean garments from the skin outward; the garments removed being destroyed, or thoroughly disinfected and cleansed as above indicated.

As yet, no reference has been made to the crew, ship, and cargo. What has been said of the treatment of those under observation, applies to every one of the ship's inhabitants. The observation, isolation, and cleansing of the crew and their effects, could safely be performed aboard ship if necessary. The ship should be thoroughly cleansed and disinfected, particular attention being given to the quarters of the emigrants and crew.

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## SECTION 4.

### INDIVIDUAL MEASURES OF PREVENTION.

#### MEANS AND MODE OF INFECTION.

Since the infectious agent exists in the evacuations both from the stomach and from the anus, various materials become capable of conveying the infection of this disease—such as clothing soiled with this matter; hands fouled with it; articles of food and drink which have been contaminated with it. It is by means of soiled clothing and personal effects upon which this agent is preserved in a more or less moist condition that the infectious principle is usually conveyed long distances, both by land and by sea. The contamination of watercourses and small streams by vomit or dejecta is perhaps the most frequent and certainly the most rapid means of producing a sudden and widely-extended outbreak of cholera infectiosa. The watercourses are not infrequently also contaminated by washing therein the personal effects of cholera patients.

Regarding the comma bacillus of Koch as the infectious agent, it has been established by numerous and exact experiments that this microbe is not only able to live for a considerable length of time in water, but is even capable of enormous multiplication therein, especially if the water contain a certain amount of organic or vegetable material. The use of such contaminated water for drinking, bathing, and culinary purposes is perhaps the most frequent mode of introduction into the human organism of the contagious principle of cholera infectiosa.

The universal practice of the watering of milk also renders this article exceedingly and especially dangerous to children during periods of the prevalence of cholera; and, where extensive and sudden local outbreaks of the disease can not be attributed directly to the use of contaminated water, it is generally the milk which conveys the cause of infection. Other articles of food are in a far less degree liable to contamination, but there are numerous examples of infection occasioned by thoughtless and accidental contamination of vegetables, fruits, and other nutritive material.

Experience has abundantly proved two laws which have an important bearing upon the spread of cholera: (1) *The tendency to infection varies exceedingly among individuals, and is with the vast majority exceedingly small.* (2) *Disturbed conditions of the digestive apparatus greatly increase the susceptibility of an individual and render him far more liable to an attack after exposure to the infection.*

It is exceedingly improbable that the infectious principle is ever conveyed to the healthy by the medium of the air; it is certainly never transported to any considerable distance in this manner. It is very doubtful, if even possible, that infection may take place through the lungs. It is certain that it can not be effected by cutaneous absorption. The disease, therefore, can not be properly termed truly contagious in the common use of that word. It is extremely

doubtful if there be a single well-authenticated case upon record where the disease has been conveyed in any other manner than by the introduction of the infectious principle into the stomach.

Still, regarding the comma bacillus of Koch as the infecting agent, it has been abundantly proved that the normal acid juices of the stomach are capable of destroying it. It is, therefore, not surprising that the examples are multiplied where water and other ingesta known to be infected have been swallowed, intentionally or accidentally, by healthy persons, without harm. If, however, this living infectious principle, the comma bacilli of Koch, escape beyond the pylorus and pass into the small intestine, the contents of which have an alkaline reaction, multiplication with enormous rapidity therein, elaboration in considerable quantity of the poisonous ptomaine, and the establishment of the disease which we recognize as cholera infectiosa, become possible.

#### PROPHYLAXIS.

The considerations already advanced suggest more or less reliable prophylactic measures. If the stomach be properly guarded against the introduction of the living infecting principle, the individual will be necessarily protected against the danger of an attack. Protective measures may be considered from two stand-points: A.—with regard to the person suffering from an attack of the disease; B.—with regard to the healthy individual exposed to infection.

A.—*With regard to the person suffering from an attack of the disease:* The evacuations from the stomach and the bowels should be immediately disinfected; where this is thoroughly accomplished, it is impossible for the infection to spread beyond the attacked. The dejecta and the vomited matter should be passed into a vessel containing a quart or more of a strong solution of carbolic acid—one part to twenty of water; and immediately after the evacuation a sufficient amount of the disinfectant should be added to make the whole quantity equal to the bulk of the evacuated material; the whole should then be gently stirred, and afterwards allowed to stand for fifteen to twenty minutes, when it should be removed and emptied into a pit containing unslacked lime, and be immediately covered by a quantity of the same material. If circumstances render it impossible thus to dispose of the disinfected evacuations, they should be emptied into a large earthen vessel containing a quantity equal to their bulk of a solution of bichloride of mercury, one part to a thousand, and stirred thoroughly therein; after remaining there for an hour or more, they may be emptied into a drain which leads to the sewer. The clothing of the patient, as well as the soiled bed-linen, immediately after removal, should be disinfected by thoroughly soaking for an hour or more in a large quantity, more than sufficient to cover them, of a strong solution of carbolic acid, one part to twenty; or they should be immediately subjected to the prolonged action of boiling water or steam. The anus, hands, and mouth of the patient should also, immediately after an evacuation, be washed with a disinfectant,—in this case, however, weaker than above indicated, say one part to ten thousand of bichloride of mercury and water, for the anus and hands, and for the mouth water slightly acidulated with sulphuric acid. The hands of the attendants, also, should be washed with the same weak solution of bichloride of mercury after handling the patient. Under no circumstances should the attendant, or any one else, eat in the same room with the sick; and, as an invariable rule which should be scrupulously observed, no person who has been in direct contact with the sick or with any of his personal effects should eat without first thoroughly cleansing and disinfecting the hands.

B.—*With regard to healthy persons exposed to the infectious principle of the disease:* Remembering what has already been remarked concerning an increased susceptibility to infection by reason of disturbance of the digestive apparatus, it is strenuously insisted upon that all causes, of whatever nature, of disturbance of the functions of the stomach and intestines, should be studiously avoided: such as intemperance of all kinds, either in drinking or in eating; all irregularities of personal habits, either as to time of meals, occupation, exercise, or hours of sleep; all emotional excitements should be removed; in short, every circumstance which experience has shown may exercise a disturbing influence upon these important functions



should be carefully guarded against; the use of articles of food which are liable to occasion indigestion, or to cause an unusual or unhealthy activity of the digestive apparatus, should be interdicted; children should be carefully prevented from indulging in exhausting sport or exercise, and should be carefully shielded against intemperate weather; it is all-important that the functions of the skin should be kept regular and active by a sufficient amount of seasonable clothing by day and by night; particular care should be taken that revulsions of blood, produced by chills, from the cutaneous surface to the internal organs, especially the abdominal, may not occur, and in this connection it is strongly recommended that the abdomen be enveloped at night by a broad band of flannel, in order that during the restlessness in sleep the skin of the abdomen may not be exposed to the direct action of the air; cold baths should be avoided; the surface of the body should be washed at not too frequent intervals, by sponging with tepid water, and afterwards dried thoroughly by vigorous rubbing with a rough towel; meanwhile, the body should be protected from draughts. Irregularity and intemperance in eating and drinking have already been alluded to. It is important that imbibition of large quantities of water or other fluids intervals between meals be avoided, for, if there were no other reason, it is a well-known physiological fact that in the intervals of digestion the reaction of the gastric juices is neutral and sometimes even slightly alkaline. If contaminated water or milk should be swallowed in large quantity during this interval, it is clear that the probability of the living infecting agent passing through the pylorus into the small intestine is greatly increased, and the possibility of an attack much enhanced. In a house where a cholera patient is suffering, the children should be kept out of the sick-room, as also all others not in attendance upon the sick. But if, as often occurs among the class of people who are mostly the sufferers from cholera—the poor and the squalid—there be only one common room for the use of the family, no one should on any account be permitted to occupy the same bed as the sick, and during the day, as also during the night, all should avoid as much as possible contact with the sick-bed.

Attention to the preparation of food is a matter of extreme importance to all persons exposed to the infection of cholera, and especially to children. It goes without saying, that the materials consumed should be perfectly fresh and sound in every respect, and that the water and milk employed should be absolutely free from the living infecting principle, as well as pure and healthy. As a guaranty against the possibility of infection by means of water or milk, both should be thoroughly boiled before use, and, as it is possible for the cholera-microbe to multiply rapidly both in water and in milk, the boiling should be *very recent*. Coffee and tea should be *recently* made and *served hot*. All food should be *thoroughly and recently* cooked. No raw food of any description, except possibly a moderate quantity of perfectly fresh, ripe, and absolutely clean fruit should be eaten. *Salads* and other such articles should be *interdicted*. Bread, as well as butter, should be carefully protected against the possibility of contamination. The culinary utensils and table-ware should be *scrupulously cleaned* with *boiling water*.

The hygienic condition of the dwelling and its surroundings should be made as perfect as possible. All decaying animal or vegetable matter should be removed. The house-drains should be free and clean and flushed with a sufficient amount of water at intervals, followed by the emptying therein of a liberal quantity of strong solution of copperas in water, or of a five-per-cent. solution of carbolic acid. The cess-pits and the privies should be kept clean and free from odor by the use of unslaked lime, large quantities of copperas, or other similar inexpensive materials. The supply for *drinking-water* should be *scrupulously guarded from possible contamination of any kind*.

Among the precautions to be enforced against a threatened attack of cholera infectiosa in any one, but especially in the young, one of exceeding importance is watchfulness over the condition of the alimentary canal. In a large number, perhaps the majority, of instances, an attack of cholera is preceded some hours or days by derangements of the digestive apparatus, such as distress or a sense of fullness or heaviness in the stomach, of gastralgia or nausea, or of occasional vomiting; or the disorders may be limited to the intestines only, and be manifested by vague general abdominal uneasiness, or slight fleeting pains, or active peristaltic

movements which can be seen or felt through the abdominal walls; and all or any of these may be associated or end with diarrhoea, and sometimes with a tendency to disproportionate prostration; or, again, the disorders of the stomach and intestines may be combined.

If these disturbances of the alimentary tract are promptly discovered and remedied, many an attack of cholera will be thereby avoided. In such cases absolute rest in bed, and, if possible, also total abstinence for a day or two from food, should be enjoined; if there be reason to infer the presence in the stomach of undigested food, a single emetic dose of ipecac should be administered; or if there be visible peristaltic movements of the intestines, or diarrhoea, these should be controlled respectively by small doses of opium in a convenient form, and of such drugs as salol, naphthalin, salicylate of bismuth, or analogous compounds.

What has been thus far said applies especially to individuals; but, unfortunately, in this disease public interests and relations must also be regarded, and from this stand-point, *so long as there are in the locality only a few scattered cases of the disease*, the utmost efforts should be made to prevent the establishment of an epidemic.

The presence of the comma bacilli of Koch in the alvine evacuations or in the vomited material from a suspicious case once determined, the duty of the attending physician and of the health officer becomes plain. The safety of the other inmates of the dwelling, and, what is of infinitely greater importance, that of the general community as regards public health and commercial interests, demand that the most skillful and intelligent physicians and nurses be procured for the sick and *kept in constant attendance*. If the dwelling be a hovel of the poor, as is usually the case, the inmates should be removed without delay to clean, healthful, and commodious quarters and kept for five or six days under strict surveillance; if the attacked is already in a desperate condition, where every prolonged disturbance increases the probability of a fatal termination, he should not be moved.

Inasmuch as the safety not only of the health and trade of the population of the locality and its immediate surroundings are involved, but also of those of great States and sometimes nations in communication with it, are seriously threatened by the escape and spread of the infectious principle elaborated in and discharged from the intestines of the person suffering an attack of cholera infectiosa, skillful and *constant attendance* is imperatively called for, and *should be provided at the public expense*. Furthermore, that same public has a paramount interest and absolute right to be *assured* that every rational precaution against the spread and dissemination of the infectious agent is scrupulously and conscientiously enforced. This is tantamount to saying that the care of the attacked and of the dwelling, as well as the custody or close surveillance of all persons associated or in communication with him or it, should be under the strict control and direction of the jeopardized public *through its own intelligent and responsible agents*. The prevention of the spread of infection—of such enormous importance to the public—should under no circumstances whatever be trusted in any degree to the ignorance or carelessness or conflicting interests of the inmates of the infected dwelling; neither should it be left to the chance of uncertainty through the incompetence or neglect or whimsical notions or personal interests or lack of authority of the private physician. Of course this means temporary invasion of the private rights and restriction of the personal liberty of a few individuals, whose own security is thereby enhanced. But the public safety demands a temporary sacrifice of private rights under these circumstances, and there should be no hesitation or vacillation in requiring it.

It is obvious that the evacuations of the intestinal canal of the attacked should, without loss of time, be carefully disinfected. But by no means all suffering an attack of cholera infectiosa are, especially in the earlier stages of the disease, so ill that they can not be out of bed, and even out of doors engaged in their ordinary vocations. Yet experience has abundantly proved that those suffering “a walking attack” carry in their intestinal canal the infectious agent of cholera, and are capable, under favoring circumstances, of establishing a center of infection wherever in their movements they may chance to void those intestinal contents. Hence the necessity of temporarily restricting the liberty of all inmates of the infected dwelling and of all persons in close communication with it, whether at the time of infection they are evidently suffering or not. All such persons should be isolated and kept under strict



surveillance until the extreme limit of the period of incubation (say, five days) has fully elapsed, *counting from the commencement of the surveillance*. If during these five days no sign of even a slight or "walking attack" has made its appearance, and finally if a culture-test, as already described, of the *feces* has indicated the absence of the comma bacilli of Koch, the individual temporarily restrained of his liberty both for his own benefit and for that of the public may be without danger restored again to the full enjoyment thereof.

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## SECTION 5.

### SANITARY MEASURES FOR PREVENTION OF CHOLERA.

It seems that the sanitary authorities of India are at last beginning to awaken to an appreciation of the folly of treating cholera in India as a non-infectious and non-transportable disease, and to return to the enforcement of the regulations, based alone on the experience of the past, which Cunningham, during his term of service as surgeon-general and chief sanitary commissioner with the Government of India, so persistently endeavored to nullify. Frequent reference has been made in this report to the prevalent belief of the East Indian surgeons in the infectiousness and transportability of cholera, whilst the public reports and the sanitary policy of Surgeon-General Cunningham nevertheless upheld in every way possible the contrary opinion. I regard it as exceedingly fortunate, not only for India but also for the whole world, that the policy pursued by the present surgeon-general and chief sanitary commissioner of India, Dr. B. Simpson, is evidently far less censorial of the opinions entertained by his subordinate medical officers than was that of his predecessor, and is getting to be more in accord as well with past experience in India as with common experience the world over.

The province of Assam is one of those outside of Bengal wherein cholera most frequently rages. I have already pointed out the peculiarity of this province in relation to the periodicity of cholera epidemics. In the general sanitary reports of Surgeon-General Cunningham, that official was accustomed to strenuously deny the probability of the importation of cholera into Assam through the agency of the movements of large numbers of coolies proceeding from or through infected districts in Bengal. In the twenty-fifth annual report of the sanitary commissioner with the Government of India for 1888, by Dr. B. Simpson, the present incumbent, an account of a serious outbreak of cholera among the immigrant coolies into Assam is given, as also of the precautionary measures to be adopted in the future. From that report I abstract the following, in order to show that the precautionary measures ordered to be enforced are based upon an appreciation of the infectiousness and transportability of cholera, and are very similar in their nature to those advocated and more or less vigorously and constantly enforced by western nations against the free movements of men during threatened invasions of cholera—precautionary measures which it has of late years been the policy of the Governments of Great Britain and India to vigorously oppose the enforcement of, whenever they have restricted the absolute freedom of navigation or of the movements of ships' crews or passengers. These abstracts need not receive further comment, for they speak for themselves:

"In the event of an outbreak of cholera a medical officer will be deputed to the Sealdah station and another to the Raneegunge station to examine emigrants, and, in communication with the railway authorities, to prevent those infected from starting. The depot from which an infected coolie comes should be ascertained in each case, with a view to the adoption of precautionary measures."

"The measures taken by the chief commissioner of Assam were as follows, as described in the Annual Report on Labor Immigration into Assam for the year 1888. In consequence of the outbreak (of cholera), the Bengal Government consented, with the previous sanction of the governor-general in council, *to prohibit emigration as a temporary measure from certain*

*parts of the Lower Provinces where cholera was very prevalent.*" (The italics are not in the original.)

"Lastly an important change has been made, whereby, on the occurrence of a serious outbreak of cholera, it is now open to managers to make arrangements for *the immediate transport* of coolies from the depôts to the gardens on the conditions that they agree to make arrangements, in accordance with certain rules which have been prescribed by the chief commissioner, in consultation with the deputy surgeon-general, for the purpose of providing for *the segregation of the coolies, both in transit to the gardens and on arrival at their destination.*" (Italics not in the original.)

Notwithstanding the already mentioned official declaration of the chief of the sanitary department of the government of Bombay that cholera is to be regarded as only a pernicious form of malaria and is no more infectious or transportable than is the latter malady, we find that sanitary commissioner for the government of Bombay in his official report for 1883 records instructions issued to villagers concerning measures to be taken against cholera which indicate a very different appreciation of the nature of the latter disease.

In fact these instructions, intended for the practical guidance of the natives of India, not only embody most excellent advice as to practical measures which may be effectively employed by an ignorant population in order to guard against a threatened visitation of cholera, but they in the most unequivocal language point out the infectious nature of cholera and especially the dangerous character of the vomit and stools, as the following verbatim quotations from these instructions demonstrate:

"12. The following order is all important to remember: The particular poison of cholera is supposed to be contained in the stools passed by the patient. It is *therefore absolutely* necessary that the stools be received into an old chattey, or other receptacle, so that they should not be spilled on the ground or bedding, *but as soon* as they are passed they should be *at once* taken *outside the village*. A little straw and *dammar* should be placed over them, and *they should be burnt*, and the ashes should be buried, and the same action should be taken regarding the vomited matter. The stool, which is like rice conjie water, is the most dangerous of all, and you must obey the directions most implicitly. Particular care must be taken on no account to bury the stools or vomit near any well, *nullah*, or tank, or throw them into the back yard or into the privy, but as *soon* as each stool is passed it should be removed outside the village. On no account should the vessel holding these stools be put down in the house or in the back yard with the intention of removing them an hour or two hence. Such a proceeding is very dangerous, for the *stools* when first passed are *not dangerous*, but they rapidly, after a very short interval, become most dangerous. The only safe course is to remove them as soon as they are passed. If the patient passes any of these stools in his bedding, no matter what the value of the article may be, it should be at once *burnt*.

"13. If the patient dies the body should be at once burnt or buried in the clothes in which he died. They should not be taken off the body."

These practical instructions contain such valuable advice concerning the precautions which should be taken in anticipation of the appearance of cholera and the measures which should be enforced on the actual appearance of cholera that they are incorporated here:

#### INSTRUCTIONS FOR THE GUIDANCE OF VILLAGERS REGARDING MEASURES TO BE TAKEN WITH REFERENCE TO OUTBREAKS OF CHOLERA.\*

##### PRECAUTIONS NECESSARY IN ANTICIPATION OF THE APPEARANCE OF CHOLERA.

1. The outbreak of cholera is often so sudden and virulent that all precautionary measures must be taken beforehand. Experience has shown that, like many other diseases, the extent of its diffusion is in no small degree dependent on local insanitary conditions, and it is therefore essential that every village should be preserved in a state of constant preparation to meet a

\* Abstract from the report of the Sanitary Commissioner for the Government of Bombay, 1883.



danger which may come at any time. Personal cleanliness is a matter of much consequence as a preventive measure.

2. If an outbreak of cholera is reported in the neighboring villages, the patil should at once, whilst the disease is at a distance, get the people to clean up the village thoroughly.

(a) All cesspools, into which the water used in bathing is discharged, should be opened up and be thoroughly cleaned out and kept clean. Especial care should be taken that the channels leading to these cesspools from the *moris* or *nanis* are not closed, but exposed to the external air. If they are closed they should be at once opened and left opened.

(b) If there is no cesspool, but the people bathe on a stone outside the house, the ground below this stone will be soddened and very unwholesome. This ground should be dug up and should be replaced by fresh and dry earth, and the people should be warned that, during this time at all events, it will be better to go outside the village to bathe at a distance from their houses.

(c) If there are any pit-privies in the village, large quantities of salt should be thrown down each and they should not be used. If there are privies on the ground, the patil should see that there is below each an iron receptacle large enough to hold the fæces, the urine, and ablution water. The ground below these privies is almost invariably soddened with foul water. Very often bamboo baskets are used. No bamboo baskets should be allowed, and the ground below should be covered every day with fresh earth.

(d) The wells from which drinking water is drawn should be very carefully looked to. Any leaves, grass, or other impurity floating on the surface should be removed. Especial care must be taken to see that there is no filth near the wells, and if there is it should be covered up with fresh earth for a depth of 6 inches. All boughs of trees overhanging the wells or tanks should be cut.

(e) The patil must visit every day the mahar and mang wada and see that these places are kept clean, and that the well is clean, and that the people have a sufficient supply of good water.

(f) All prickly-pear near a village should be cut, dried, burnt, and the ashes buried in a hole where it will make good manure for the fields.

(g) The patil should pay increased attention, in order to make the people go outside the village to a selected site for natural purposes.

(h) He should make the village mahar go through the village every day and especially examine the sites of ruined houses, and if there is any ordure in them the site should be cleaned and inclosed by a mud wall so as to prevent access to it, and all night-soil found in the streets or other places inside the village should be cleaned up and removed.

(i) The night-soil at the inclosure outside the village should not be thrown behind prickly-pear trees, etc., but it should be buried in a trench 1 foot deep and 1 foot wide and be daily covered with earth for a depth of at least 6 inches.

(j) It would be well in all villages if such trenches were daily used by the villagers. Each person after using should kick a little earth over what he had passed. This was done at the camps during the famine and was found very successful; for women and children, who can not go outside the village, an iron bucket should be provided into which a little dry earth should be thrown, and it should be daily carried to the fields and the contents buried.

3. When cholera is reported to be prevalent in the neighborhood the patil should warn the villagers that a great measure of safety would be to boil all their drinking water, and after boiling it well for five minutes to put it to cool in a clean vessel before drinking. Boiling destroys in a great measure the hurtful impurities in the water and is one of the greatest safeguards we have.

4. But if cholera has actually broken out in a village, filth must not be disturbed or dug up. The best thing to do, under these circumstances, is to cover it up with fresh earth for a depth of 6 inches and the patil should advise the villagers to have their houses immediately lime-washed inside with hot lime-wash and it would be a good plan if each householder would burn inside each room in his house 6 ounces of sulphur in a pipkin. Whilst the sulphur is burning all persons must remain outside, as the sulphur fumes would kill them if they staid inside.

All doors and windows and other openings should be closed whilst the sulphur is burning; after four hours they should be opened and left open, so that the fresh air may be admitted.

5. The patil should always obtain from the mamlatdar and keep in stock a sufficient quantity of medicine for diarrhoea as well as for cholera; and he should, if an outbreak of cholera is apprehended, give warning to the villagers that it is especially necessary that they should apply to him *at once* at any hour, by day or night, for medicine, if any member of their family is attacked with *looseness of the bowels*.

6. The disease can easily be checked at this stage, but if it is allowed to go on without taking medicine it may be fatal. Any person, therefore, who goes to the rear even once more often than customary should *immediately* ask the patil to give him medicine. It is very dangerous to wait. As soon as he has obeyed the call of nature he should go *forthwith*, without any delay, to the patil and get the medicine which will prevent the disease getting hold of him. If it is night he should go *at once*, and not wait till daylight. This is most *important*.

#### MEASURES TO BE ADOPTED ON THE APPEARANCE OF CHOLERA.

7. The patil should warn the people to abstain from drinking spirits. The practice of drinking spirits is believed to be a certain promoter of the disease, and they should not be taken on any account.

8. It will be well if a grass shed can be put up outside the village for the treatment of any wayfarers who may be attacked by cholera. They should not be allowed to enter the village, but the patil should arrange that such persons are provided with suitable food, water, and medicine.

9. When cholera appears in a village it is most important to remember that this disease evidently attaches itself to particular localities. The principle to be borne in mind, therefore, is that the particular locality in which cholera shows itself must be looked on as dangerous. If possible, the house should be immediately abandoned. It would be a measure of safety to move any person attacked away to a shed or open place situated outside the village, quite away from the place he was attacked in.

10. As plenty of fresh air greatly assists the chances of recovery, the friends and relatives should not crowd around the person attacked, but only one or at the most two people should remain with him.

11. The patient should lie, if possible, on a cot, and not on the ground. He should be fanned, and one man should shampoo his legs and arms if he has cramps. Cold water which has been boiled may from time to time be given him to drink. He should be given the cholera medicine according to the directions, but if the surface of the body is quite cold, if the lips are blue, if the eyes appear to be glazed, it is no good giving him medicine, but he should be well shampooed and the surface of the body be rubbed well with the palms of the hands. He should, if he will take it, be given hot mutton broth at frequent intervals. If his caste will not allow him to eat this, he should be given hot arrowroot conjie. It is very important to have the doors and windows left wide open; never mind if he feels cold; fresh air is most important, and he can be covered with clothes; but at all hazards give him plenty of fresh air, and do not let more than two people be in the same room with him.

12. The following order is all-important to remember. The particular poison of cholera is supposed to be contained in the stools passed by the patient. It is therefore *absolutely necessary* that the stools be received into an old chatty or other receptacle so that they should not be spilt on the ground or bedding, *but as soon as* they are passed they should be *at once* taken *outside the village*. A little straw and dammer should be placed over them, and *they should be burnt*, and the ashes should be buried, and the same action should be taken regarding the vomited matter. It must not be expected that the stools will be solid fecal matter. They will be more like rice conjie water, and you must not say it is only water, and therefore throw it down anywhere. The stool which is like rice conjie water is the most dangerous of all, and you must obey the directions most implicitly. Particular care must be taken on no account to bury the stools or vomit near any well, nullah, or tank, or to throw them into the



back-yard or into a privy; but as *soon* as each stool is passed it should be removed outside the village. On no account should the vessel holding these stools be put down in the house or in the back-yard with the intention of removing them an hour or two hence. Such a proceeding is very dangerous, for the stools when first passed are *not dangerous*, but they rapidly, after a very short interval, become most dangerous. The only safe course is to remove them as soon as they are passed. If the patient passes any of these stools in his bedding, no matter what the value of the article may be, it should be at once *burnt*.

13. If the patient dies, the body should be at once burnt or buried in the clothes in which he died; they should not be taken off the body.

14. If a second case occurs in the same house all the inmates should be turned out, and after the recovery or death of the patient 1 pound of sulphur should be burnt in a pipkin in the room in which the patient was. Whilst the process of disinfection is going on the doors, windows, and other openings should be closed and kept closed for four hours, after which time they should be opened. The floor should be dug up and the earth taken outside the village and be buried. The walls should be lime-washed and a portion of the tiles be removed from the roof, or if it is a mud roof an opening should be made in it so as to allow plenty of *light* and *air* to enter, and the inmates should not be allowed to re-enter the house for at least ten days.

15. If these simple instructions are carried out, it is hoped that many lives will be saved, but much will depend on whether these instructions are carried out to the letter; and the people at times when there is no cholera should be warned that the surest preventive of cholera is to have clean air, clean food, clean water, clean houses, and clean persons.

The standing orders establishing the regulations for the management of cholera among the East Indian army embody, as is declared by the recent surgeon-general, "rules founded on the general experience of the past," which "must be considered as the guide on all ordinary occasions," regardless of etiological theories which may from time become prevalent. It is partly for the reason that these rules of management are based upon wide practical experience, and have been the means of saving to the East Indian Government great numbers of lives and immense pecuniary losses, and partly for the reason that these "rules," which have withstood the severest test of wide experience in the land where cholera constantly rages, are based upon an acceptance of the infectiousness and transportability of cholera, and, in my opinion, constitute a complete answer to those Indian sanitary officials of high authority, who, ignoring the experience of the vast majority of their subordinates in India, and holding as naught that of almost the whole medical world outside of India, proclaim, in the interests of the freedom of trade, the non-infectiousness and the non-transportability of cholera, that I have subjoined a verbatim reproduction of the most essential sections thereof. From the latter stand-point I would direct the attention of the reader especially to sections 29, 37, 43, 45, 46, 49, 51, 55, 56, 57 and 60 of the following:

#### MEASURES ENFORCED ON OUTBREAK OF CHOLERA AMONG THE INDIAN ARMY.\*

The following *Rules regarding the measures to be adopted on the outbreak of cholera amongst British troops* are published for information and guidance:

##### A.—PRECAUTIONS NECESSARY IN ANTICIPATION OF THE APPEARANCE OF CHOLERA.

1. The outbreak of cholera is often so sudden and virulent that all precautionary measures must be taken beforehand. Experience has shown that, like many other diseases, the extent of its diffusion is in no small degree dependent on local unsanitary conditions, and it is therefore essential that every station should be preserved in a state of constant preparation to meet a danger which may come at any time. The personal cleanliness of the men is a matter of much consequence as a preventive measure.

\* Abstract from army regulations relating to management of cholera, which the late Surgeon-General Cunningham declared to be based solely upon long experience in India, without regard to theoretical considerations.

2. General and other officers in command should at all times give their utmost attention to the conservancy and general sanitary condition of a station. If an outbreak appears probable, every ordinary precaution should be attended to with increased vigilance; but if the disease has actually appeared in the cantonment or its vicinity, more harm than good is likely to arise from any attempts at improvement which may then be made. This is not the time to cleanse foul drains or to remove nuisances which may have hitherto been neglected, and such possible sources of disease should, in these circumstances, be left undisturbed.

3. Whenever cholera is to be apprehended, the staff surgeon and cantonment magistrate should keep a special watch on the condition of the bazaars, and any case of cholera should be immediately reported to the officer commanding the station. The register of deaths should be carefully scrutinized.

4. Especial care should be taken to prevent crowding in barracks and hospitals; and during the hot season a portion of the men should be permitted to sleep in tents pitched for the purpose in the vicinity of the barracks. If cholera threatens, even though the men may have the full regulated amount of space, they should be spread out as much as possible, advantage being taken of any spare buildings which can be conveniently employed.

5. The early treatment of premonitory symptoms is of very great importance, and of these looseness of the bowels is the chief. At seasons, therefore, when cholera threatens, and still more so when it is more than usually prevalent, commanding officers should give the most precise orders on this subject, and see that measures are taken for paying the most vigilant attention to the health of the men in the barracks, and for treating in observation wards all slight cases of diarrhoea or other disease which, if neglected, might pass into cholera. As the men during cholera times have a natural dread of going into hospital, and are apt on this account to conceal the early symptoms in order to escape being sent there, it is of importance that every facility for the immediate treatment of diarrhoea should be afforded them in barracks.

Non-commissioned officers in each room should accordingly be provided with suitable medicines, care being taken that the proportion of opium or any other dangerous drug should be small.

6. Whenever new buildings are being carried on, it is most important, with regard to the health of their future occupants, that the ground and water in the neighborhood should be protected from pollution. Special care must be taken that proper conservancy arrangements are organized for workmen, coolies, etc., and that the orders are strictly enforced. The workmen should not be allowed to sleep in or about barracks and other public buildings under construction. In exceptional cases, where no accommodation exists, temporary huts should be erected for them.

7. If cholera appears in the neighborhood, the soldiers and other residents of cantonments should be warned against the danger of visiting the affected locality. The same principle should be acted upon on all occasions so long as the disease continues, for visiting any place where cholera exists is always attended with more or less risk. As one valuable means of attaining this object, the provision of stores attached to the regimental canteen should be encouraged, so that soldiers and their families may be able to supply their wants without going to the city or bazaars.

8. Camping grounds to be used in the event of an outbreak of cholera have now been selected for all cantonments. Some of them are in the neighborhood and others at a greater distance, involving several marches or a journey by rail. If cholera threatens, officers commanding divisions, districts, or stations should make themselves acquainted with the condition of these camping grounds *at the time*, the state of the roads leading to them, and the supply of carriage available. Information should also be daily obtained from the civil authorities as to the history of cholera in the vicinity of each. In some instances slight expenditure may be needed for improving the drainage or water supply of the grounds, both of which should receive careful attention.

9. When the particular ground or grounds to be used has to be decided, regard should be had—to the previous history of the neighborhood, whether the place has been specially liable to,



or exempt from, cholera—to the experience of bodies of men moved to them on account of cholera in former years—to the *history of cholera in the villages around it at the time, whether the disease prevails among them or not*—to the character of the ground as regards elevation, drainage, supply of good water, and the presence of trees which afford valuable shade. Readiness of access is also an important element to be taken into account, and in this point of view camping grounds to be reached by rail should be within a short distance of the line

#### B.—MEASURES TO BE ADOPTED ON APPEARANCE OF CHOLERA.

10. If cholera has been prevalent in the neighborhood, and if more than one case occur among the soldiers or their families under such circumstances as have been above stated, then formation of the preparatory camp should be considered imperative. The size of this camp will, of course, depend on the strength of the garrison and other circumstances. In some cases it will be advisable to provide for a proportion of the whole garrison, in others only for part of a particular regiment or battery. The exact size of the camp must be decided by the local authorities after a full consideration of all the facts and of the amount of danger to be anticipated. The previous history of the station as regards cholera will afford valuable data on this point.

11. All necessary arrangements should, under the authority of the officer commanding, be made by the commissariat department in connection with the civil authorities for providing carriage, so that it may be at once available in case of its being required.

12. All information received by the military authorities should be at once communicated by them to the chief civil authorities of the district, who in their turn must be held responsible for obtaining immediate notice of the outbreak of cholera in their jurisdiction, and of communicating the fact to the military authorities without delay.

13. The transmission of information regarding cholera need cause no alarm. If it be thought necessary, the reports may be considered confidential; but it is believed that this will seldom or never be desirable. The knowledge that the attack of the disease is considered possible will be far more likely to produce beneficial than mischievous results, and the belief that the authorities are alive to the danger and prepared to meet it, will tend to allay, rather than to increase, alarm.

14. The utmost unanimity is essential in all departments to give effect to the above recommendations; all should work cordially for the public good and in constant communication with the civil authorities, whose hearty co-operation is especially needed with regard to the supply of carriage. They should use every lawful means to prevent delay in obtaining carriage for the troops, as the loss even of a few hours in moving troops away from a station may lead to most serious consequences. On all occasions every use should be made of the movable column carriage. All movements of troops and changes of camping ground should be at once reported to the civil authorities of the district.

15. Special attention should be paid to everything which can tend to the improvement of the general health of the men. Every effort should be made to relieve them from duties which cause needless exposure and fatigue, and especially to avoid night duty, so far as this may be possible with due regard to military considerations; to insure that their food is wholesome and their clothing appropriate; and to promote every means of healthy amusement and occupation.

16. It often occurs that soldiers, on a visitation of cholera, indulge in the use of spirituous liquors, under the impression that they are a preventive against the disease. Medical authorities unanimously condemn this baneful practice as a certain promoter of the disease, and commanding officers should therefore exert their influence in every way to prevent it.

17. On a case of cholera occurring in any building occupied by European troops, the room, or portion of the building in which it occurred, should be *immediately* vacated, and, except for the purpose of purifying it, no one should be allowed to enter it; if the whole building can be left, it will be still better. This is laid down as an absolute rule; for, although individual cases of cholera sometimes occur when there is no reason for anticipating an outbreak, instant removal from the building in which a case has occurred is the best safeguard; and, besides,

it is necessary that the room or building in which the disease has shown itself should be vacated for the purpose of being purified. When men, under the above circumstances, are removed from a building, they must be kept separate, so far as may be possible, from the men among whom the disease has not shown itself, and, in arranging for their accommodation, care must be taken that there should be no overcrowding either of them or of others. Should no separate buildings be available, it is desirable that they be placed under canvas.

18. In carrying out this rule, the tents should be pitched in some convenient spot in the cantonment, and where only an individual case has occurred among the body of men so removed, this arrangement will, as a rule, be the best which can be adopted.

19. It is to be distinctly understood that these rules are equally applicable to the women and children if cholera should appear in their quarters, and that they are to be as strictly carried out, but endeavors should always be made to assign available buildings to them, so that the necessity of moving them into camp may, if possible, be avoided.

20. Ten days after removal, and when the room or building which was vacated has been purified in the manner hereafter described, it may be re-occupied, provided no other circumstances have occurred meantime which may render such re-occupation undesirable.

21. If a second case of cholera appears among the particular body so removed they should be again moved. If a third case occur among this particular body within one week from the occurrence of the first case, then the men composing it should be immediately removed from the station to the preparatory camp.

22. The procedure here laid down, if carried out with promptitude in successive instances, will often be found sufficient to arrest the further spread of the disease, but when cases occur in several buildings, either simultaneously or at short intervals, and especially if there be at the same time any unusual prevalence of diarrhœa, an outbreak of cholera is seriously to be apprehended, and it will, under such circumstances, be advisable at once to remove the inmates of affected buildings to the encampment outside cantonments.

23. It is to be remembered that when an outbreak threatens, removal from the affected locality is the only remedy in which any confidence can be placed, and that the earlier the movements are carried out the greater will be the chance of success.

24. Cholera evidently attaches itself to particular localities. The principle to be borne in mind therefore is, that the particular locality in which cholera shows itself must be looked upon as dangerous, that it must be immediately abandoned and all communication with it stopped, and that the body of men who have been exposed to danger by their occupation of the place in which the cause of the disease is presumed to be present must be separated from the rest of the troops. If, for example, this body consists only of the inmates of some one building, the measure need only be applied to them; if some particular battery, troop, or company be attacked, it will be similarly dealt with. A whole regiment or the whole of the troops at the station, need only be sent into camp when it is found that the measures already adopted have not stopped the progress of the disease or there is reason to fear they will be insufficient. As a rule, it is necessary only to vacate such buildings as have actually presented cases.

25. When separate detachments are moved into camp in the manner indicated, it is advisable that they be kept distinct as far as possible. Officers commanding stations are authorized to call freely for medical aid from other stations, districts, or divisions free from cholera; and where a separate hospital establishment can not be assigned to each party it may be convenient to place a hospital in some central position not far removed from two or more camps, the sick from which may be treated together. Such arrangements must be left to the decision of the local authorities.

26. On the first appearance of cholera at any of the stations on the line of railway, intimation should be given to the railway officials of the probabilities of a movement being required in order that the necessary trains may be in readiness, so that if any move be decided upon it may be carried out without delay. Tents should also be forwarded by rail and pitched at the selected camp.



27. As, however, all stations on the line of railway are in telegraphic communication with army headquarters, no move by rail should be made without the sanction of his excellency the commander-in-chief, obtained through the quartermaster-general, every preparation being meanwhile made in anticipation, and the troops, if necessary, being moved temporarily into a convenient camp.

28. In some cases, to avoid fatigue, it may be advisable to encamp the men close to the station of departure so that they may start by rail in the early morning, and they may encamp again for a night close to the station of arrival before going onto the selected ground next morning.

29. Previous to detachments proceeding by rail the military authorities must arrange for trenches being dug in the vicinity of one or two of the stations at convenient intervals on the journey, so that all discharges may be received in them. The troops on no account should be allowed to use the railway station latrines. These trains should not stop at stations except when necessary to procure fuel, etc., they might stop for a few minutes from time to time on the line.

30. As the movement will be made in the hope that the troops may be in this manner carried out of the affected area, the camp will probably be occupied for some time, and the strictest possible attention should be paid to conservancy; trenches should be dug to leeward, and sheltered by matting or grass screens, and all filth instantly covered with earth. A similar system should be adopted for the camp-followers and other natives, who are also to be provided with tents or other good and sufficient shelter for their accommodation while in camp. The strictest regulations must be laid down and enforced by the commanding officer to insure attention to this all-important point.

31. In arranging the camp, the tents should be spread over a large area, and any military considerations or regulations in regard to distances between tents should give place to the desirability of allowing free ventilation, so far as this can be done with convenience. Tents should not be pitched immediately under trees, as they prevent the free access of air at night, and during the rains prevent their drying.

32. As a rule not more than eight men should be placed in each tent.

33. Immediate benefit is not always to be expected from the movement into camp, and the occurrence of a few cases of cholera ought not to be looked upon as proof that the change has proved a failure. It is clear that men often take with them the seeds of cholera, and although the immediate cessation of the disease is by no means uncommon, it is unreasonable to suppose this will be always the case. Even if the first apparent result be an aggravation of the disease, this need cause no discouragement.

34. If the disease continue to be virulent for more than three or four days, a fresh camping ground may be tried by a short movement, at right angles, if possible, to the prevailing wind or track of the disease. The marches should always be short, if possible not more than 2 or 3 miles; movement should generally be made in very open order and in the morning, in time to admit of the new ground being reached soon after sunrise; but if the march is very short, it may be made in the evening, whenever the delay of a night is regarded as unadvisable risk. The men will be supplied with hot tea or coffee before starting; they will invariably wear flannel belts, and every precaution must be taken to prevent their remaining in damp or wet clothes, especially when the movements are made by rail. It is of the utmost importance that fatigue and exposure should be avoided, and everything possible should be done to keep the men cheerful and in good spirits.

35. When all the troops in a station are sent into camp on account of an outbreak of cholera, all ordinary sick capable of being removed without evident danger should go into camp also; the few patients who can not possibly be removed should be transferred to one small general hospital, which will usually be found sufficient for all those who must remain in cantonments.

36. Charpoys are to be taken into camp for all the men, so that there may be no necessity for their sleeping on damp ground. Should the season of the year not necessitate these being

taken, straw will be supplied, on requisition, by the commissariat department. If the troops travel by rail, the straw can either be taken in the train or be furnished by the commissariat at the selected camp.

37. The utmost attention must be paid to the drinking water. At camping grounds which have been frequently used, caution will be especially necessary, and, if considered desirable, temporary wells must be sunk, so that there may be no danger of water, contaminated by organic matter, being supplied to the troops. As a precautionary measure, *the water used for drinking should be boiled*, and as the taste of water subjected to this process is insipid, the reason for this proceeding should be carefully explained to the men. The filters belonging to British regiments are to be taken with them when the troops are moved into camp on account of cholera; but they should first be carefully cleansed and supplied with fresh charcoal. *No water derived from sources in cantonments used by the infected body of men should be taken into camp.*

38. It not unfrequently happens that troops are allowed to return far too soon to cantonments or to buildings which have been infected with cholera, and the consequence is re-appearance or aggravation of the disease. The return to cantonments must only be allowed with the greatest caution. No part of the cantonment from which the disease has not altogether disappeared, should be re-occupied. Under no circumstances can the re-occupation of any building which has been attacked by cholera be allowed, unless at least ten days have elapsed since the last case of cholera in the building, nor until every measure for the purification of the building, as laid down in paragraph 55, has been carried out. The prevalence of fever or other diseases in camp is no reason for returning to cantonments while danger from cholera remains. It must be accepted as the lesser evil of the two.

39. When it has been found necessary to incur any expense for the benefit of the troops during the prevalence of cholera, a special report, giving every particular, should be at once made to the quartermaster-general for the information of his excellency the commander-in-chief and of the Government.

40. Tents belonging to a regiment are to be retained in all cases for regimental purposes, and are not to be lent to the civil authorities for the use of prisoners in the event of epidemics breaking out in jails, or on other occasions.

41. When tents are required for cholera cases among the troops, the oldest and least serviceable must be selected, provided they are fit for the purpose. At all stations where the ordnance department can supply unserviceable tents, such tents should be applied for and used for cholera patients instead of serviceable tents in possession of regiments and batteries. On the outbreak of cholera at stations where no ordnance depot exists, when time will admit of it, and the charges for carriage by rail will not be excessive, application should be made by telegraph to the nearest ordnance depot or magazine within a moderate distance, where there are unserviceable tents in store, with a view to the required number being issued for use during such outbreak. The unserviceable tents issued on an outbreak of cholera or small-pox may be retained at the stations of Gwalior, Jhansi, Morar, and Saugor, for such period after the cessation of the epidemic as may be considered necessary by the military authorities, they being duly accounted for to the examiner of ordnance accounts. At all other stations tents so issued are to be returned into store when no longer required.

42. In most cases the established proportion of camp equipage will be sufficient to accommodate that portion of the garrison which may be necessary to move into camp. Extra camp equipage should, therefore, not be indented for unless the epidemic should prove severe, and render it probable that a larger proportion than half the garrison may have to be removed from cantonments. When the necessity for this has been admitted, commanding officers are to indent on the nearest magazine for such additional camp equipage as they may require; the indents to be countersigned by the deputy surgeon-general or the senior medical officer on the spot, and by the officer commanding the station.

43. The question of hospital management during the prevalence of cholera is one of urgent importance. No sanitary precaution must for a moment be neglected; no approach



to anything like crowding must be permitted; all unimportant cases, the treatment of which in hospital is not essential, should be discharged; every case in hospital must be carefully watched; and it must be borne in mind that in very numerous instances it is in the hospital, among patients under treatment for other diseases, that cholera first appears. Precautionary measures in the hospitals must be commenced, whenever it may be possible, before the actual appearance of the disease; and, as laid down in paragraph 5, all slight symptoms of disease must be treated in the barracks or in observation wards.

44. If no separate building can be set apart as a temporary hospital, tents or suitable grass huts should be provided for the purpose in some convenient place at a little distance. Every arrangement must be made so that if a case of cholera should occur it may be immediately removed there, and not be treated in the regular hospital. For the treatment of patients suffering from cholera tents are unobjectionable at all seasons of the year. The air in a tent or grass hut is less likely to become contaminated, and the ground can be changed as often as may be desirable. Medicines and everything considered requisite for the treatment of the disease should be in readiness.

45. Patients attacked by cholera should not, when avoidable, be placed in the same ward with patients suffering from other diseases. If a patient in hospital suffering from another disease be attacked with cholera, or if a case occur among the hospital attendants or others, the same systems must be adopted as have been ordered in the event of cholera appearing in other buildings occupied by troops.

46. Every effort should be made, during the actual treatment of the disease, to get rid, as completely as possible, of all the discharges from the sick. The vessels in which they are received should contain some disinfectant; and the contents should be freely mixed with dry earth and thrown into a trench dug for the purpose; and all vessels should be thoroughly cleansed at the trench into which the filth is thrown.

47. During the prevalence of cholera at a station, such changes in the diet, and such other medical comforts, are to be allowed to the troops as the deputy surgeon-general or senior medical officer may deem expedient. In directing these comforts to be freely supplied, particularly to the women and children, the senior medical officer on the spot will be required to exercise a wise discretion to avoid unnecessary expenditure, and to see that the indulgence is not abused.

48. On the occasion of an outbreak of cholera at a station the entertainment of natives to attend Europeans soldiers in hospital suffering from that disease is authorized to such an extent as the local medical authorities may consider necessary; the men being provided, on requisition, by the commissariat department.

49. When the employment of European soldiers as orderlies in hospitals during the prevalence of cholera is considered unavoidable, men will be selected, as far as possible, by volunteering in such number as the medical authorities may deem necessary. The complete tour of duty shall in no case exceed twenty-four hours, and no man who is not in good health shall be thus employed. No orderly is to be kept in actual attendance in the hospital for a longer period than four hours at one time, nor is he to have a less interval of rest than six hours between successive tours of duty, whatever be the period of attendance in the ward. A room entirely separate from the hospital buildings must be provided for the accommodation of men relieved from attendance on the sick, in which they can remain until their tour of duty again comes around. Men not upon actual duty are not to be allowed to remain in the hospital. The strictest precautions must be taken to prevent men employed in the hospital from making use of the latrines, urinaries, or wash-houses used by the sick in hospital. The utmost care must be taken that the hands of all attendants on cholera patients be scrupulously cleaned, and that if the clothes of any of the men should become soiled by cholera discharges they be at once taken off and thoroughly purified. Every man employed as an hospital orderly in attendance upon cholera patients is to be provided with tea or coffee at the public expense before and after each tour of duty.

50. For attendance on women and children suffering from cholera, native female nurses should if possible, be procured.

51. Careful arrangements must be made for the removal of the sick from the barracks to the hospital, and on no account should the doolie employed for this purpose be made use of for the removal of the dead.

52. On the appearance of cholera or any other epidemic in the sudder or regimental bazaar of a station, arrangements should be made for the treatment of all cases seeking it, especially if poor or friendless; suitable hospital accommodation should be provided in a convenient position and supplied with essential requisites for the comfort and proper treatment of the sick voluntarily presenting themselves for admission, and to the utmost extent the medical staff and funds at disposal of local authorities will permit. But no person should be forcibly taken from their friends or removed to such hospitals under any pretense whatever. Medicines made up in a suitable form should be provided to all who apply for them.

53. The hospital will be under the medical charge of the station staff surgeon, or other medical officer selected by the deputy surgeon-general, and the establishment as following, to be increased if necessary, will be attached to it, the servants to be discharged on the subsistence of the epidemic: One hospital assistant; 1 ward servant; 2 cooks; 2 bheesties, 1 Hindoo and 1 Mahommedan in each class; 2 sweepers; doolie with four bearers.

54. When cantonment funds can be made available, without withdrawing them from such measures of conservancy as may be considered of even more importance, all expenses incurred by the establishment of these temporary hospitals, including the dieting of the patients, if that be also involved, should be defrayed by them. The primary objects of such funds being to secure the proper sanitary condition of a station in every possible way.

(Dr. Cuninghame adds to these comprehensive standing orders relative to the management of cholera in the Indian army, the following explanation:

*Note.*—Although the foregoing rules enjoin the great importance of promptly abandoning any locality in which cholera has appeared, and the great importance of giving the strictest attention to cleanliness, whether as regards the discharges of the sick or any other filth, it is to be distinctly understood that they do not imply that there is any danger in attendance on the sick or in otherwise coming in contact with persons suffering from cholera.) [This is a gratuitous assertion made by Dr. Cuninghame, and does not harmonize at all with his declaration that these rules are based solely *upon experience* in the successful management of cholera and regardless of theoretical considerations. E. O. S.]

#### C.—FUMIGATION AND DISINFECTION.

55. When a case of cholera is reported, the room in which it has occurred must be thoroughly purified and fumigated. All furniture and wood should be washed with country soap and water, and the walls, ceiling, and punkahs scraped and whitewashed. The windows and doors should be kept open for several days. The latrine, urinary, and wash-house used by the person attacked must be instantly closed, and their use not permitted until they have been thoroughly purified; carbolic acid, Macdougall's powder, or some other disinfectants should be freely used; all filth and rubbish from the latrine must be removed to a distance, and all vessels used for their removal must be carefully cleaned and disinfected at the place where the refuse is deposited.

56. The straw of the barrack bedding used by persons attacked prior to admission into hospital will be burnt. The stuffing of mattresses and pillows used by cholera patients in hospitals will be opened out, exposed to the air, and beaten, and, when practicable, submitted to a dry heat of not less than 212 degrees Fahrenheit for at least two hours (in an oven or otherwise) before being used again, the remainder of the barrack and hospital bedding, clothing, etc., and such of the clothing worn by patients on their admission as is not liable to injury thereby shall be boiled, exposed to the air, beaten, and afterwards washed with soap and water. Cots and punkah fringes, which have been used by cholera patients, or in wards set apart for them, should also be subjected to the action of boiling water when they are no longer required for such cases. Such articles of a soldier's kit as can not be treated in the above manner will be removed to hospital and there fumigated and exposed to the air and sun for a



week, beaten, and brushed. Burning only to be resorted to when purification can not be at once carried out.

57. When circumstances are such that the above processes of purification can not be at once carried out, such articles as body linen, bedding, cots, and punkah fringes may be burnt, but with proper arrangements the necessity for this destruction will rarely arise.

58. Tents used by cholera patients before being struck shall be fumigated, and then left exposed to the weather for ten days.

59. When fumigation is considered to be necessary, one of the following processes will adopted:

(a) With chlorine gas:

	Ounces.
Common salt.....	4
Oxide of manganese, in powder.....	1
Sulphuric acid.....	1
Water.....	2

The water and acid to be mixed together and then poured over the ingredients in a delf basin, which should be placed in a pipkin of hot sand.

(b) With nitrous acid gas:

	Ounces.
Copper shavings.....	$\frac{1}{2}$
Nitric acid.....	$1\frac{1}{2}$
Water.....	$1\frac{1}{2}$

Pour the acid and water upon the copper in a small jar.

(c) With sulphurous acid gas: Burn 2 ounces of sulphur in a metal basin.

All doors and windows and other openings in the room or tent should be closed before commencing fumigation. The operator should leave the room immediately after the process has commenced. At the expiration of two or three hours all doors and windows should be thrown open and free ventilation established. The rooms should be entirely emptied before being fumigated.

60. The excreta from patients suffering from cholera shall be subjected to disinfection by the most suitable disinfectants at command; they should be received in vessels containing some of the disinfectant, and immediately covered with more of the same material or with dry earth. The vessel should never be emptied into the usual receptacle, but taken away separately and thrown into a trench dug for the purpose at a safe distance from occupied localities or sources of water supply. A man should be constantly employed at the trench to throw dry earth over all filth the moment it is deposited. All vessels should also be thoroughly cleansed at the trench into which the excreta are thrown.

#### D.—OTHER POINTS REQUIRING THE SPECIAL ATTENTION OF MEDICAL OFFICERS.

63. In any epidemic it is of the greatest importance to ascertain all the circumstances connected with the appearance of the first case, and a very careful investigation should be made at once in order to discover, if possible, whether it was due to importation. Such inquiries, if delayed, are usually unsatisfactory.

64. The condition of the camp-followers, of the punkah coolies and others who come about the barracks, should receive attention, and orders should be issued that any suspicious cases occurring among them be reported so that they may be at once investigated. With the assistance of the non-commissioned officers such cases of sickness should not escape detection. Arrangements should be made for the early treatment of those attacked either in camp or cantonments, and where the general cholera hospital for natives is distant, measures should be adopted for attending to their wants on the spot. A careful note of all such seizures and of the circumstances under which they occur should be preserved.

#### RECORDS OF SPORADIC CHOLERA ABOLISHED.

65. In the forms the term choleraic diarrhœa has been abolished. All such cases distinguished by rice-water evacuations should be returned as cholera.

66. It is very desirable that the terms sporadic and epidemic should not be used in connection with reports of cases of cholera. There are no means of distinguishing between the two, and the exact significance of individual attacks can be known only when all the facts regarding the prevalence of the disease throughout the year have been ascertained and considered as a whole.

67. In some instances, cases of cholera in which reaction has taken place have been discharged, and the fatal event which afterwards occurred recorded under the head of fever. This system produces great error in the statistics, and it ought on no account to be followed. No cases of cholera should be discharged until every symptom either directly or indirectly due to the disease has disappeared.

68. When no cases of cholera have occurred for several days, an opinion is apt to prevail that the disease has disappeared, but it must be remembered that at certain seasons a lull is to be expected. This generally occurs in the early part of the monsoon. With regard to it no decided rule can yet be laid down, but it is important that the fact of there having been no cases for some time should not lead to any relaxation of the necessary precautions and preparations in anticipation of a further, and generally more severe, outbreak.

#### F.—RESPONSIBILITY OF COMMANDING OFFICER.

76. On the officer commanding the station will devolve the responsibility of having all the directions continued in these rules, as regards the evacuation and purification of buildings, the movements into camp, and all other details, carefully carried out.

77. These rules, founded on the general experience of the past, must be considered as the guide on all ordinary occasions. As in outbreaks of cholera, however, so much depends on the judgment and action of general and other officers, they must exercise their own discretion whenever extraordinary emergencies or unforeseen circumstances occur, and, in consultation with the senior medical officer, must take upon themselves the responsibility of action incumbent on their position. Whenever it may be considered advisable to deviate from the procedure prescribed in these rules, a special report, explaining fully the reasons for so doing, must be forwarded to the quartermaster-general for the information of the commander-in-chief.

78. It must be distinctly understood that commanding officers are not authorized to establish or enforce against the public at large, or any section thereof, any quarantine or any restrictions in the nature of quarantine as against cholera in particular, which are not equally applicable at all times to the control of vagrant classes of people having no legitimate ground for claiming admission within cantonment limits. The employment of the troops to form cordons round cantonments for such purposes is strictly prohibited, discipline in this, as in other matters, being enforced by the ordinary means placed at the commanding officer's disposal for such purposes, and it is to be carried out without additional expense to the state beyond that authorized by these rules.

#### SUMMARY OF SECTIONS IN WHICH INFECTIOUSNESS OF CHOLERA IS DIRECTLY OR INDIRECTLY ADMITTED.

For the convenience of the reader I have abstracted from the preceding regulations for the management of the Indian army during cholera prevalence those portions which more or less explicitly admit the infectious nature of cholera.

Section 29. "The troops on no account should be allowed to use the railway station latrines. These trains should not stop at stations except when necessary to procure fuel, etc.; they might stop for a few minutes from time to time on the line."

Section 37. "As a precautionary measure *the water used for drinking should be boiled. No water derived from sources in cantonments used by the infected body of men should be taken into camp.*"

Section 43. Under hospital management: "all unimportant cases, the treatment of which in hospital is not essential, should be discharged."



Section 45. "Patients attacked by cholera should not, when avoidable, be placed in the same ward with patients suffering from other diseases."

Section 46. "Every effort should be made during the actual treatment of the disease to get rid, as completely as possible, of all the discharges from the sick. The vessels in which they are received should contain some disinfectant; and the contents should be freely mixed with dry earth and thrown into a trench dug for the purpose; and all vessels should be thoroughly cleansed at the trench into which the filth is thrown."

Section 49. "A room entirely separate from the hospital buildings must be provided for the accommodation of men relieved from attendance on the sick. Men not upon actual duty are not allowed to remain in the hospital. The strictest precautions must be taken to prevent men employed in the hospital from making use of the latrines, urinaries, or wash-houses used by the sick in the hospital. The utmost care must be taken that the hands of all attendants on cholera patients be scrupulously cleaned, and that if the clothes of any of the men should become soiled by cholera discharges they be at once taken off and thoroughly purified."

Section 51 admits the infectiousness of cholera cadavers.

Section 55 admits that a cholera patient may infect his immediate surroundings, the vessels used in conveying his discharges and the latrines, drains, etc., into which they are emptied.

Sections 56 and 57 admit the same for the bedding, etc., used by the patient, and advise destruction of them.

Section 60 distinctly admits the infectious nature of cholera stools.

Section 66 unequivocally admits the different nature of so-called sporadic cholera and epidemic cholera, but orders that no distinction be made in reports between the two on account of the difficulty of differential diagnosis.

Section 77 declares that, "These rules, founded on the general experience of the past, must be considered as the guide on all ordinary occasions."

#### *RÉSUMÉ OF THE CONCLUSIONS ADOPTED AND OF THE PROPOSITIONS REJECTED BY THE TECHNICAL COMMITTEE OF THE INTERNATIONAL SANITARY CONFERENCE OF ROME (1885).\**

[For the information of the reader it should be stated that those sections of the following protocol which begin with the Arabic numerals were adopted by the committee, whilst those beginning with capital letters were rejected by them.

The subjects upon which the following votes were recorded are as follows:

Exchange of sanitary information, sections 1, 2, 3. Sanitary prophylaxis against cholera, section 4. Disinfection, section 5.

A.—Sanitary prophylaxis upon land, sections 6, 7, 8, 9, A, 10, B, 11, 12, 13.

B.—Sanitary prophylaxis upon rivers, sections 14, 15, C.

C.—Sanitary prophylaxis by sea: ports, sections 16, 17, 18; ships "suspected" and "infected," sections D, 19, 20, 21. Sanitary measures at the port of departure, special measures: passenger steamers, sections E, 22, 23, 24, 25, 26, 27, 28, F; small vessels, sections 29, 30, 31, 32, 33.

Sanitary measures during the voyage: passenger steamers—suspected vessels, sections 34, G, 35, 36—infected ships, sections 37, 38, 39; small ships, sections 40, 41.

Special regulations for the Red Sea: passenger steamers—suspected ships, sections 42, 43, 44, 45, H—infected ships, sections 47, 48, 49, I, K, L; small vessels, section 51.

Pilgrimages to Mecca: sections 52, 53, 54, 55, 56, 57, 58, 59, M, 60, 61, 62, 63, 64, 65, 66, 67.

Sanitary measures at the port of arrival: suspected vessels, sections 68, 69, 70, O; infected ships—the sick, sections 71, 72—passengers and crew, sections 73, 74, P, 75, 76, 78—ships, section 77.

Special measures on the Mediterranean: suspected ships, sections 79 Q, 80 R, S, 81 T; infected ships, sections 82 U, V.

Special measures for the Sea of Marmora and for the Black Sea: suspected ships; infected ships, section X.

Sanitary prophylaxis for the Caspian Sea, section 83.

Sanitary prophylaxis against yellow fever, section 84. E. O. S.]

#### I.—SANITARY INFORMATION.

1. In each country there should be a central bureau of sanitary information and notification. All of these bureaus should be in regular correspondence with each other.

\* Translated by the American delegate.

Adopted by 18 affirmative votes against 1 negative (Switzerland) and 1 abstention (Holland).

2. The technical commission expresses the wish that the International Sanitary Conference may affirm the necessity of publishing an international statistical bulletin for each important city. This should be uniform as to its basis and form, and should show each week the total number of deaths, the number of deaths caused by each of the epidemic diseases, and particularly from cholera and from yellow fever.

Adopted unanimously, with the exception of the delegate from Turkey, who abstained from voting.

3. The first cases of cholera or of yellow fever which appear in a locality, and especially in the maritime ports, should be reported at once, by telegraph, to the different Governments.

Adopted unanimously.

## II.—SANITARY PROPHYLAXIS AGAINST CHOLERA.

4. General sanitation and isolation, real and complete—in the measure indicated by science—of everything which might introduce the disease, are the best means of preventing the importation and propagation of cholera.

Adopted in principle.

### DISINFECTION.

5. The commission recommends, as means of disinfection against cholera, besides destruction—

(1) Steam at 100° C.

(2) Carbolic acid, chloride of lime.

(3) Aeration.

Carbolic acid and chloride of lime are to be used in aqueous solution.

Weak solutions: Carbolic acid, 2 per cent.; chloride of lime, 1 per cent.

Strong solutions: Carbolic acid, 5 per cent.; chloride of lime, 4 per cent.

These means of disinfection will be applied as follows:

I. For the disinfection of persons the weak solution should be employed.

II. For the disinfection of clothing, bedding (*des linges, des habits, des couvertures*), and other articles of this kind: (*a*) destruction; (*b*) steam passed through the articles for one hour; (*c*) boiling for thirty minutes; (*d*) immersion for twenty-four hours in one of the weak disinfecting solutions; (*e*) aeration for three or four weeks, but only in case the other means recommended are inapplicable.

Articles of leather, such as trunks, boots, etc., should be either destroyed or washed several times with one of the weak disinfecting solutions.

III. Vomited matters and the dejections of the sick should be mixed with one of the strong disinfecting solutions, in quantity at least equal to the amount of material to be disinfected. Linen, clothing, bedding, etc., recently soiled by the dejections of the sick, which can not be immediately subjected to the action of steam, should be at once immersed in one of the strong disinfecting solutions and left for four hours.

IV. The dead should be enveloped in a sheet saturated with one of the strong disinfecting solutions, without previous washing of the body, and at once placed in a coffin.

V. Disinfection of merchandise and of the mails is unnecessary; steam under pressure is the only reliable agent for the disinfection of boiled rags (*les chiffons en gros*).

VI. When cases of cholera occur upon a vessel at sea, the locality where the case occurs should be disinfected. The floor and walls of the cabin or other locality should be washed at least twice with one of the weak disinfecting solutions and then exposed freely to fresh air.

In the case of objects of considerable value, which have not been in immediate contact with the sick and which would be seriously injured by a rigorous disinfection, the physician on board may determine what measures are necessary to protect the sanitary interests of the vessel.

The bilge-water should be pumped out and replaced by sea-water at least twice at each disinfection of a vessel.



The closets should be well washed with one of the strong disinfecting solutions at least twice a day.

VII. If the drinking water is open to suspicion it should be boiled before it is used, and the boiling should be repeated if it is not used within twenty-four hours.

All suspected food should be destroyed, or at least recently cooked.

VIII. Hospitals should be disinfected by washing the floors and walls with one of the weak disinfecting solutions, by a subsequent free ventilation and cleansing, and finally by repainting. The wards to be disinfected should, as far as possible, be isolated from those in use.

The latrines should be disinfected at least twice a day by pouring into them the strong disinfecting solutions in quantity at least equal to the amount of the dejections received since the last disinfection.

IX. The clothing worn by physicians and attendants should remain in the hospital, and should be regularly disinfected.

Physicians and attendants should use the weak disinfecting solutions for washing their hands, etc.

Adopted unanimously, with the exception of the delegate from Turkey, who abstained from voting.

#### A.—SANITARY PROPHYLAXIS UPON LAND.

6. Land quarantines and sanitary cordons are useless.

Adopted by 20 affirmative against 1 negative vote (Turkey).

7. In order to prevent the development of cholera and its propagation upon land, it is necessary—

(1) To attend to general sanitation everywhere and at all times, to isolate the first cases, and to disinfect. The means of isolation and of disinfection should be prepared in advance under the advice of the sanitary authorities.

(2) To announce immediately every declared or suspected case of cholera to the proper authority, according to the laws of the country, and to have the nature of the disease verified by competent physicians, or the cause of death by an autopsy.

(3) There should be in every country an organized medical hygienic service. Officers of this service should be stationed in the districts and in the principal cities in sufficient number to bring every inhabited locality within the scope of this hygienic supervision.

(4) The sanitary authorities of the different countries should be able to communicate with each other directly, without an intermediary, whenever they find it necessary, in order to obtain information or to agree upon urgent measures to be taken.

Adopted unanimously.

8. In time of cholera particular attention should be paid to the highways upon which those sick with cholera might travel and to the principal points of arrival, in order to apply in good time necessary sanitary measures, isolation of the sick, and disinfection.

Adopted unanimously.

9. At principal stations upon grand land routes which are passed over by numerous laborers or emigrants, physicians should, as far as possible, be stationed for the purpose of caring for the sick.

Adopted unanimously.

A.—The rules of hygiene should be scrupulously executed on railway trains and at stations. A physician should be attached to each important station, which should be provided with a suitably isolated chamber for the sick.

Rejected by 13 votes (Austria, Hungary, Brazil, Denmark, Spain, Italy, Mexico, Holland, Portugal, Roumania, Servia, Switzerland, Turkey), against 8 affirmative (Germany, United States, France, Great Britain, India, Russia, Sweden, Norway).

10. Direct trains which pass through several countries should be changed in passing from an infected country to one which is free from the disease. They should be accompanied by a physician whose duty it is to take the necessary measures in case a traveler fall sick en route.

Rigorous cleanliness should be observed upon the train and at railroad stations. Each station should have at least one chamber separated from the rest, in which to receive patients temporarily.

Adopted by 10 affirmative votes (Austria, Hungary, Brazil, Denmark, Spain, Italy, Mexico, Portugal, Servia, Switzerland), against 6 negative votes (Germany, France, Holland, Roumania, Sweden, Norway), and 5 abstentions (United States, Great Britain, India, Russia, Turkey).

B.—The entrance of passenger cars, and especially of sleeping-cars, coming directly from infected localities should be forbidden. At all important stations and at each frontier station there should be a physician to care for the sick and for the medical inspection; a place for the isolation of the sick should also be provided. At custom-house stations every one should be obliged to leave the train for medical inspection. The most rigorous neatness should be observed upon the trains and at the railway stations.

Rejected by 11 negative votes (Germany, Brazil, Spain, France, Great Britain, India, Portugal, Russia, Servia, Sweden, Norway), against 9 affirmative (Austria, Hungary, Denmark, United States, Italy, Mexico, Holland, Roumania, Switzerland), and 1 abstention (Turkey).

11. The disinfection of persons should be accomplished by means of disinfecting washes only, and will only be necessary in case they have been soiled by the dejections of cholera patients.

Adopted unanimously, with the exception of 1 abstention (Spain).

12. As everything which comes from an infected country is not necessarily infected, it will only be necessary to disinfect that which has been soiled, or which may have been in use by cholera patients, and especially linen, clothing, and rags.

Adopted unanimously, with the exception of one abstention (Turkey).

13. The general rules of hygiene, applicable at all times, should be followed with greater rigor than usual in time of cholera, and especially those relating to the crowding of individuals, the supplies for markets, provisions, drinking water, the transportation of the sick, the burial of the dead, etc.

Adopted unanimously.

#### B.—SANITARY PROPHYLAXIS UPON RIVERS.

14. Ports upon rivers which receive sea-going vessels should be subjected to the same regulation as sea-ports.

Adopted unanimously.

15. Passenger boats upon large rivers should be subjected to a rigorous hygiene. Overcrowding with passengers should be strictly prohibited. A physician should be stationed at each important landing, and a properly isolated room should be provided at each station.

Adopted unanimously, with one abstention (Turkey).

C.—Sanitary cordons placed along a great river are effective, because complete isolation of the sick can be realized.

Rejected by 13 votes (Germany, Austria, Hungary, United States, France, Great Britain, India, Italy, Holland, Russia, Sweden, Switzerland), against 5 affirmative (Spain, Mexico, Roumania, Servia, Turkey) and 3 abstentions (Brazil, Denmark, Portugal).

#### C.—SANITARY PROPHYLAXIS BY SEA.

##### *General Sanitary Measures.*

##### PORTS.

16. It is the interest of each nation to assure the salubrity of its sea-ports. It will often thus avoid the invasion of its soil by exotic maladies, and above all will rarely transport upon its vessels endemic diseases.

Adopted unanimously.

17. In each port it will be necessary to have at all times a sanitary authority, whose mission it shall be to furnish consuls official information relating to the sanitary condition of the port.

Adopted unanimously.



18. Consuls will be permitted to obtain from the bureaux of hygiene information relating to the sanitary condition of sea-ports and of cities.

Adopted by 10 affirmative (Austria, Hungary, United States, France, Italy, Mexico, Holland, Portugal, Russia, Switzerland), against 2 negative (Roumania and Turkey), and 8 abstentions (Germany, Brazil, Denmark, Great Britain, India, Japan, Sweden, Norway).

SHIPS.—DEFINITION OF TERMS "SUSPECTED SHIP" AND "INFECTED SHIP."

D.—Every ship not provided with a physician and coming from a locality or from a port where cholera exists, will be considered as suspected.

Every ship which has, or has had, on board one or several deaths since her departure from a locality or from a port where cholera exists, if there is not a physician to certify as to the cause of death, will be considered as infected.

Every ship which has, or has had, on board one or several cases or deaths from cholera, will be considered as infected. If, however, the ship has a physician, if the voyage has lasted longer than ten days, if there has been no case of cholera during the last ten days, and if the necessary measures of isolation and disinfection have been taken, the ship will not be treated as infected, but as suspected.

If the ship has, or has had, on board a case of sickness which may be suspected of being cholera, the port physician will decide, after having consulted the physician of the ship, whether the ship should be treated as suspected or as infected.

A ship free from suspicion which has communicated with a suspected ship, and especially if it has received passengers from this latter, becomes suspected; and every ship which has communicated in the same manner with an infected vessel will be considered infected.

Countries, localities, and sea-ports are either immune or infected, never suspected.

Lost by 9 negative votes (France, Great Britain, India, Sweden, Norway, Holland, Roumania, Servia, Turkey), against 9 affirmative (Germany, Austria, Hungary, Spain, United States, Mexico, Portugal, Russia, Switzerland) and 3 abstentions (Brazil, Denmark, Italy).

19. Every ship destined for the transportation of passengers, which sails from a suspected port, should be properly constructed and should be provided with facilities for the isolation of cholera patients.

Adopted unanimously.

20. Passenger steamers sailing from countries where cholera reigns should be provided with an apparatus for disinfecting by steam.

Adopted unanimously.

21. Steam-boats destined for the transportation of travelers coming from countries where cholera prevails should have on board a physician, appointed by the Government to which the vessel belongs, or by the sanitary authority, whose appointment is revocable only by that Government or sanitary authority, and who is completely independent of the companies of navigation or the owners of the vessel.

Adopted by 19 affirmative, with 2 abstentions (Sweden, Norway).

SPECIAL SANITARY MEASURES.

*Measures of Sanitation at the Port of Departure—Passenger Steamers.*

E.—It is desirable that the sanitary state of ships about to sail be verified by a personal inspection made by an authorized agent of the country of destination.

Rejected by 9 negative votes (Austria, Denmark, Spain, Japan, Holland, Roumania, Russia, Servia, Sweden) against 2 affirmative (United States, Italy) and 11 abstentions (Germany, Brazil, France, Great Britain, Hungary, India, Mexico, Norway, Portugal, Switzerland, Turkey).

22. The consul of the country of destination will have the right to assist at the sanitary inspections of the ship made by the agents of the territorial authority, in conformity with the rules which may be established by conventions or treaties.

Adopted by 8 affirmative votes (Austria, Hungary, Denmark, United States, Italy, Holland, Portugal, Sweden), against 6 negative votes (Great Britain, India, Japan, Roumania, Servia, Turkey), and 8 abstentions (Germany, Brazil, Spain, France, Mexico, Norway, Russia, Switzerland).

23. The unloading of the vessel will not commence until it has been put in good sanitary condition, either by the ordinary means or by special measures of disinfection, if considered necessary. For this purpose it will be inspected by the captain and the ship's physician. The result of the inspection will be noted upon the ship's register.

Adopted unanimously.

24. The doctor will examine the passengers coming from a port where cholera prevails, and will refuse to receive on board those who appear to him to be suspicious.

Adopted unanimously, except 1 abstention (Turkey).

25. He will see that those who appear to him to be in good condition do not bring on board linen, personal effects, or bedding contaminated or open to suspicion.

Adopted unanimously.

26. Clothing and bedding which have been in use by persons who have died of cholera should never be received on board.

Adopted unanimously.

27. When cholera shows itself on board a ship while it is at an infected port, those who show the first symptoms of this disease will be immediately sent to the hospital, and all of their effects, such as bedding, etc., which have been in use will be destroyed or disinfected.

Adopted unanimously.

28. The "sacks" inclosing the clothing of individuals who died aboard will be disinfected before a vessel leaves.

Adopted unanimously.

F.—All of the personal effects of travelers to sail from a port where cholera prevails should be disinfected.

Rejected by 18 votes against 4 (Spain, Portugal, Italy, Mexico).

#### SMALL VESSELS.

29. From a sanitary point of view it is necessary to distinguish two kinds of vessels—those which have a physician and those which have not. The latter should be considered small vessels (*petits navires*), whatever may be their tonnage and the number of their crew, whether they are sailing vessels or steam-vessels.

Adopted unanimously with the exception of Spain.

30. Before one of these "small vessels" is loaded the captain should request the consul of the country to which the vessel is destined to have his ship inspected by a physician, who should also examine his passengers before sailing. The inspection to be independent of that made by the sanitary authorities of the port.

Adopted by 20 affirmative against 1 negative (Brazil) and 1 abstention (Turkey).

31. The result of this inspection, together with the directions as to measures of sanitation and disinfection required, will be recorded in the ship's register.

Adopted unanimously, except one abstention (Turkey).

32. Earth or porous material of any kind should not be used as ballast.

Unanimously adopted.

33. The captain should see that no infected or suspected articles of wearing apparel, personal effects, or bedding are permitted to come on board.

Adopted unanimously.

#### *Measures of Sanitation During the Voyage.*

#### PASSENGER STEAMERS (GRANDS PAQUEBOTS).—SUSPECTED VESSELS.

34. The soiled body linen of the passengers and crew should be washed at once, after having been immersed in boiling water or in a disinfecting solution.

Adopted unanimously.



G.—The soiled linen of suspected individuals, either passengers or belonging to the ship, should be washed at once, after having been immersed in boiling water or in a disinfecting solution.

Rejected by 14 to 5.

(Note.—Evidently this proposition was rejected in favor of the more comprehensive one which precedes it, and not because the conference was opposed to the measures of the disinfectants proposed.—Translator.)

35. The closets—"lieux d'aisance"—should be washed and disinfected at least twice a day.

Adopted unanimously.

36. Rigorous cleanliness and active ventilation should be maintained during the voyage on board suspected ships.

Adopted unanimously.

#### INFECTED SHIPS.

37. As soon as the doctor observes the first signs of cholera he will immediately notify the captain, and in concert with him, will take the necessary measures for the isolation of the sick.

Adopted unanimously.

38. The localities occupied by those who fall sick with cholera should be disinfected immediately.

Adopted unanimously.

39. As far as possible the localities thus disinfected should remain freely exposed to the air and unoccupied, and should not be assigned to any passenger in health during the remainder of the voyage.

Adopted by 19 affirmatives against 1 negative (Spain), and 2 abstentions (Great Britain and India).

#### SMALL SHIPS.

40. During the voyage the captain should take all the measures necessary for the disinfection of the body linen of the passengers and crew, for the isolation of the sick in case of cholera, and for the disinfection of localities. He should note all this upon the ship's register.

Adopted unanimously.

41. In order that the captain may be able to properly attend to these requirements, the consul of his nation will place in his hands, before his departure, clear and concise sanitary instructions, to be hereafter drawn up. These instructions will be translated into the different languages and offered to the different Governments for distribution.

Adopted unanimously, with 1 abstention (Brazil.)

#### SPECIAL REGULATIONS FOR THE RED SEA.

##### PASSENGER STEAMERS—SUSPECTED SHIPS.

42. All steamers coming from cholera-infected localities beyond the straits of Bab-el-Mandeb will be subjected to a medical inspection in the Red Sea.

Adopted by 16 affirmative votes against 4 negative (Brazil, Spain, Great Britain, and India) and 2 abstentions (United States and Japan).

43. This inspection will be made by an independent physician belonging to the port.

Adopted by 17 affirmative against 1 negative (Spain) and 4 abstentions (United States, Great Britain, India, and Japan).

44. If the ship's physician certifies that the necessary sanitary measures have been taken at the point of departure, and that proper measures of sanitation and disinfection have been observed during the voyage; that there has not been during the voyage a death from cholera or a recognized or suspected case; finally, if the medical examination made by the port physician permits him to certify that there is no one on board sick with this disease, or suspected of being so, *free pratique* will be granted immediately.

Adopted by 17 affirmative against 1 negative (Spain) and 4 abstentions (United States, Great Britain, India, and Japan).

45. The ships which are not to leave any passengers at the ports of the Red Sea, and particularly in Egypt, will be subjected to a medical inspection near Suez.

Adopted by 16 affirmative against 2 negative (Spain and Turkey) and 4 abstentions (United States, Great Britain, India, and Japan).

H.—English merchant ships, troop ships, mail steamers, and others which do not communicate with Egypt or with any European port should always be permitted to pass through the Suez Canal without inspection, as through an arm of the sea.

Rejected by 18 votes against 2 (Great Britain, India), and 2 abstentions (Japan, Russia).

46. Ships which carry passengers destined for Egypt or for any port of the Red Sea will be subjected to a first inspection near the Strait of Bab-el-Mandeb and to a second at the first port of arrival.

Adopted by 17 affirmative against 1 negative (Spain) and 4 abstentions (United States, Great Britain, India, Japan).

#### INFECTED SHIPS.

47. If the ship is infected, that is to say, if there is or has been one or more cases of cholera on board, the passengers will be disembarked and isolated in separate groups, each containing as small a number as possible.

Adopted by 18 against 2 (Great Britain, India,) with 2 abstentions (Brazil, Japan).

48. The ship and the clothing and personal effects of the passengers and crew will be disinfected.

Adopted by 19 affirmative votes, with 3 abstentions (Great Britain, India, Mexico).

49. The passengers and crew of the vessel will be kept under observation five days.

Adopted by 13 affirmative votes (Germany, Austria, Denmark, Hungary, France, Japan, Italy, Holland, Portugal, Russia, Sweden, Norway, Switzerland), against 9 negative (Brazil, Spain, United States, Great Britain, India, Mexico, Roumania, Servia, Turkey).

I.—The passengers and crew will be subjected to an observation of ten days, which will commence at the date of the last case of cholera.

Rejected by 16 votes against 5 (Brazil, Denmark, Spain, Japan, Mexico), and 1 abstention (Turkey).

K.—The passengers and crew will be subjected to an observation of ten days.

Rejected by 15 against 7 (Brazil, Denmark, Spain, Mexico, Roumania, Servia, Turkey).

50. The sick will be isolated and placed in care of and under the responsibility of the physicians.

Adopted by 18 against 1 (Brazil), with two abstentions (Great Britain, India).

L.—The sick will be placed in quarantine and left to the care and disposition of physicians.

Rejected by 14 against 4 (Brazil, Spain, Mexico, Servia), with 4 abstentions (Great Britain, Portugal, Roumania, Turkey).

#### SMALL VESSELS.

51. Small vessels which come from the Indian Ocean and enter the Red Sea only, landing passengers at ports in this sea, should be treated in the same manner as large vessels under the same circumstances. When they only pass through this sea going from the Indian Ocean to the Mediterranean they will be subjected to a double inspection—one at the entrance to the Red Sea, the other at Suez. If they are free from infection they may continue their route; if they have had cases of cholera on board they will be treated in the same manner as the "large vessels" which are infected.

Adopted by 17 against 1 (Spain), with 4 abstentions (Brazil, Great Britain, India, Turkey).



*PILGRIMAGES TO MECCA.*

52. It is desirable that each pilgrim should possess the resources necessary to preserve him from want during this pilgrimage to Mecca, a regulation which is in conformity with the provisions of the Mohammedan religion and which has been adopted by the Government of the Dutch East Indies. This measure will prevent distress (*la misère*), which is one of the most important causes of the extension of cholera among the pilgrims.

Adopted unanimously.

53. Every pilgrim ship and every caravan should be accompanied by a sufficient number of physicians, designated by the Government of the country from which the expedition starts.

Adopted unanimously.

54. A ship will be considered a "pilgrim ship" if it has on board more than thirty pilgrims.

Adopted unanimously.

55. In those ports where cholera exists the ship will be cleaned and disinfected before the embarkation of the pilgrims and will be inspected by its physicians and also by the sanitary authority of the port. The physician of the ship will examine each person and will only admit such as are free from cholera and free from suspicion of this malady. He will see that no infected or suspected clothing, personal effects, bedding, or other articles are brought on board. All articles coming from infected or suspected localities will be disinfected before they are brought on board. Clothing and bedding which have been in use by cholera patients will never be received on board.

If cholera manifests itself on board of the ship the sick will be immediately sent to the hospital, and the locality which they occupied upon the ship will be at once disinfected.

Adopted unanimously.

56. The sanitary authority of the port of departure and the physician of the ship will see to it that the ship is not overcrowded. A steam-ship should have between decks, for each passenger, at least 9 feet of surface and 54 cubic feet of space. On sailing vessels each passenger should have 12 feet of surface and 72 cubic feet of space.

Adopted unanimously.

57. During the voyage the ship's physician will see that a rigorous cleanliness and active ventilation are maintained, and that all soiled or dirty linen is washed and disinfected at once, and that the closets are washed and disinfected at least twice a day.

Adopted unanimously.

58. In general, all the measures adopted by the British Government in India relating to the embarkation and transportation of pilgrims from India on the Red Sea are recommended for the adoption of all countries from which pilgrims depart.

Adopted unanimously.

59. Every pilgrim ship arriving in the Red Sea will stop at the sanitary station, where it will be subjected to a rigorous medical inspection. The inspection of the passengers and crew will be made on shore. The ship and the effects of the passengers and crew will be disinfected, the captain will then take the necessary measures to insure the complete cleansing of the ship, the washing of the effects of the passengers and crew.

If the ship's doctor certifies that all necessary measures of sanitation and of disinfection have been taken before sailing; that the measures of sanitation and disinfection have been observed during the voyage; that there has not been during the voyage any death from cholera, or any recognized or suspected case; finally, if the medical examination, made twice within twenty-four hours, by the physician of the sanitary station, shows that there is no case of cholera and no suspicious case, the passengers and crew may be re-embarked and the vessel may proceed to its destination at Hedjaz.

If the ship is without a physician, or if there have been cases of cholera, or suspected cases, on board during the voyage, or if cases occur after the arrival of the vessel at the sanitary station, it will be isolated for five days and disinfected, together with all the effects of the

passengers and crew. The passengers and crew will be isolated upon land for five days. The sick and suspected persons will be isolated in separate groups. The well will be divided into groups, each of which will be permitted to re-embark at the expiration of five days since it has been separated from the last case of the disease, if there have been any.

The ship will be permitted to proceed to its destination at Hedjaz, when all of the groups of passengers have been re-embarked, with the exception of those who have been isolated because of contamination, and who have not yet been subjected to the period of detention fixed.

Adopted by 16 against 5 (Brazil, Spain, Mexico, Servia, Turkey).

A proposition identical with the preceding, with the exception of the thirteenth line, was voted upon and rejected.

M.—If the ship is without a physician, or if there have been cases of cholera, or suspected cases, on board during the voyage, or if cases occur after the arrival of the vessel at the sanitary station, it will be isolated for *seven* days, etc.

Rejected by 17 votes against 5 (Brazil, Spain, Mexico, Servia, Turkey).

60. Upon its arrival at Hedjaz the ship will again be subjected to a rigorous medical inspection. A delay of twenty-four hours will be accorded to the physician of the port, if he judges it necessary, to enable him to formulate the result of his sanitary inspection. If the ship's physician certifies there has been no case, or suspected case, of cholera on board since the ship left the sanitary station, and if the inspection made by the physician of the port enables him to testify that there has been no death from cholera and no case of this disease, the ship will be granted *free pratique* at once.

If, on the contrary, there have been cases, or suspected cases, the ship should immediately return to the sanitary station and there be subjected anew to all of the measures of observation, isolation, and disinfection described in the preceding article.

Adopted unanimously.

61. The physicians present, those who have been delegated or sent for this duty, as well as those who have arrived with the ships or with the caravans, will follow the pilgrims during the entire duration of their pilgrimage. They will be charged with insuring an efficient sanitary service which may prevent the development of cholera among the pilgrims, and if the disease appears they should care for the sick and notify the interested governments as promptly as possible.

Adopted unanimously.

62. It is absolutely necessary that sanitary measures be enforced in the localities where the pilgrims remain, and especially in the holy cities of the Hedjaz.

Adopted unanimously.

63. If there has not been a case of cholera during the entire duration of the pilgrimage the pilgrim ships will be subjected to a rigorous medical inspection at the port of embarkation. Ships destined for Egypt, and those which are to pass through the canal to the Mediterranean, will be subjected to a second inspection, the first in the Egyptian ports, and the others (those destined for the Mediterranean) near Suez. This second inspection will decide whether these ships can be considered clean or whether they should be subjected to observation and disinfection.

Adopted unanimously, with 2 abstentions (Great Britain, India).

64. If during the pilgrimage there have been cases of cholera the ships destined for the ports of Egypt and of the Mediterranean will be sent to a sanitary station, where they will be subjected to an observation of five days, counting from the isolation of the sick, and the complete disinfection of their effects and of the ship, under the conditions indicated for infected or suspected ships upon their arrival. They will also be subjected to a second medical inspection at the port of arrival in Egypt or near Suez.

Adopted by 14 against 5 (Brazil, Spain, Mexico, Servia, Turkey), and 2 abstentions (Great Britain, India).

N.—If there have been cases of cholera during the pilgrimage the ships destined for ports of Egypt or of the Mediterranean will be sent to the sanitary station, where they will be



subjected to an observation of seven days, counting from the isolation of the sick, and the complete disinfection of their effects and of the ship, under the conditions indicated for infected or suspected vessels upon their arrival. They will also be subjected to a second medical inspection at the ports of arrival in Egypt or near Suez.

Rejected by 16 negative votes against 5 (Brazil, Spain, Mexico, Servia, Turkey).

65. Small vessels coming from the Indian Ocean and entering the Red Sea, if they carry pilgrims, will be subjected to the special *régime* prescribed for pilgrim ships.

Adopted by 17 against 1 (Spain), with 4 abstentions (Brazil, Great Britain, India, Turkey).

66. The technical commission has no authority to fix the places where the sanitary stations will be established and those where the medical inspection will be made, but from the information at hand it appears that the island of Camaran for pilgrim ships coming from the south, Aioun Ouna and the coast of Attaka for those which return from the pilgrimage of Mecca, and who are to land at ports of Egypt or of the Mediterranean, present favorable conditions.

Adopted unanimously.

#### SANITARY PENAL CODE FOR THE RED SEA.

67. The technical commission expresses the wish that the International Sanitary Conference may establish the basis of an international penal code applicable to contraventions of the sanitary regulations established for the Red Sea.

Adopted unanimously, with 2 abstentions (Great Britain, India).

#### *Sanitary Measures at the Port of Arrival.*

##### SUSPECTED VESSELS.

68. Free pratique will not be accorded until a sanitary inspection has been made, by daylight, by a physician of the port of arrival, which inspection should establish the exact sanitary condition of the passengers and crew, and the fact that the necessary measures of sanitation and disinfection have been rigorously executed at the point of departure and during the voyage.

Adopted by 17 against 2 (Brazil, Spain); two abstentions (Portugal, ——).

69. The passengers will receive free pratique if there is not and has not been on board either death or case, or suspected case, of cholera.

Adopted by 15 against 3 (Brazil, Spain, Mexico), and 3 abstentions (Denmark, Great Britain, India).

70. When the voyage has been of less than ten days' duration there will be an observation of twenty-four hours, and a disinfection on board of soiled linen and personal effects.

Adopted by 11 votes against 6 (Brazil, Spain, United States, Great Britain, India, Mexico), and 4 abstentions (Austria, Denmark, Servia, Turkey).

O.—In case the voyage has been of less than ten days' duration there will be an observation of seven days, and a disinfection on board of soiled linen and personal effects.

Rejected by 12 votes (Germany, Austria, Hungary, United States, France, Great Britain, India, Italy, Sweden, Norway, Holland, Roumania) against 3 (Brazil, Spain, Mexico), and 6 abstentions (Denmark, Portugal, Russia, Servia, Switzerland, Turkey).

##### INFECTED SHIPS.

##### THE SICK.

71. The sick will be immediately removed to an isolated locality on shore.

Adopted unanimously, save 1 abstention (Turkey).

72. Disinfection will be practiced as already directed in the articles relating to disinfection.

Adopted unanimously.

## PASSENGERS AND CREW.

73. The passengers and crew will be isolated.

Adopted by 17 votes against 2 (Great Britain and India), and 2 abstentions (United States and Russia).

74. This isolation will last for five days.

Adopted by 11 votes against 8 (Brazil, Spain, Great Britain, India, Mexico, Roumania, Serbia, Turkey), and 2 abstentions (Denmark, United States).

P.—This isolation will last for ten days.

Rejected by 13 votes against 7 (Brazil, Denmark, Spain, Mexico, Roumania, Serbia, Turkey); 1 abstention (Portugal).

75. In case the physician of the ship is able to certify that there has not been a case of cholera on board for ten days, the observation may be reduced to twenty-four hours.

Adopted by 10 votes (Germany, Austria, France, Italy, Holland, Russia, Sweden, Norway, Switzerland) against 7 (Brazil, Spain, Mexico, Portugal, Roumania, Serbia, Turkey), and 4 abstentions (Denmark, United States, Great Britain, India).

76. The passengers will be divided into groups, each containing as small a number as possible, so that if cases occur in one group the time of isolation will not be prolonged for all.

Adopted by 18 votes against 3 abstentions (United States, Great Britain, India).

77. The sanitary authority will adopt such measures of disinfection as may be necessary, and will prescribe the measures of prophylaxis which have been approved by this Conference.

Adopted by 18 votes, with three abstentions (Denmark, Great Britain, India).

## SHIPS.

78. The ship will be disinfected in accordance with the directions given in the articles relating to disinfection. All these measures of disinfection will be executed in presence of and under the responsibility of the chief sanitary authority of the port of arrival.

Adopted unanimously.

## SPECIAL MEASURES FOR THE MEDITERRANEAN.

## SUSPECTED SHIPS.

79. The passengers and crew will be landed in an isolated locality which is provided with all of the means necessary to carry out the directions relating to disinfection and isolation.

Adopted by 10 votes (Brazil, Denmark, Spain, France, Italy, Mexico, Portugal, Roumania, Serbia, Turkey), against 4 (Austria, Hungary, Great Britain, India), and 7 abstentions (Germany, United States, Holland, Russia, Sweden, Norway, Switzerland).

Q.—It will not be necessary to land the passengers and crew if the journey has lasted more than ten days.

Rejected by 10 votes (Brazil, Spain, France, Italy, Mexico, Portugal, Roumania, Serbia, Switzerland, Turkey) against 5 (Austria, Hungary, Denmark, Sweden, Norway), and 6 abstentions (Germany, United States, Great Britain, India, Holland, Russia).

80. This isolation will vary from three to six full days, according to the condition of the ship, whether it is a large steam-vessel or a small ship, and to the fact of its having or not having a physician on board.

Adopted by 6 votes (France, Italy, Norway, Holland, Portugal, Switzerland) against 5 (Brazil, Spain, Mexico, Serbia, Turkey), with ten abstentions (Germany, Austria, Hungary, Denmark, United States, Great Britain, India, Roumania, Russia, Sweden).

R.—This isolation will vary according to the condition of the ship, to whether it is a large steam-vessel or a small ship, and to the fact of its having or not having a physician on board. This isolation will last at least ten full days.

Rejected by 9 votes (Brazil, France, Italy, Holland, Portugal, Roumania, Sweden, Norway, Switzerland) against 4 (Denmark, Spain, Mexico, Turkey), and 8 abstentions (Germany, Austria, Hungary, United States, Great Britain, India, Russia, Serbia).



S.—This isolation will vary from five to seven full days, according to the condition of the ship, to whether it is a large steam-vessel or a small ship, and to the fact of its having or not having a physician on board.

Rejected by 6 votes (France, Italy, Mexico, Holland, Sweden, Norway), against 5 (Brazil, Spain, Roumania, Servia, Turkey), and 10 abstentions (Germany, Austria, Hungary, Denmark, United States, Great Britain, India, Portugal, Russia, Switzerland).

81. The duration of the voyage will be deducted from that fixed for the period of isolation.

Adopted by 7 votes (France, Italy, Holland, Portugal, Sweden, Norway, Switzerland) against 6 (Brazil, Spain, Mexico, Roumania, Servia, Turkey), and 8 abstentions (Germany, Austria, Hungary, Denmark, United States, Great Britain, India, Portugal, Russia, Switzerland).

T.—If the voyage has not lasted ten days free pratique will not be accorded until after an observation of seven days, during which the exact sanitary condition of passengers and crew will be ascertained, and soiled linen will be disinfected.

Rejected by 6 votes (France, Italy, Holland, Portugal, Sweden, Norway) against 4 (Brazil, Spain, Mexico, Turkey), and 11 abstentions (Germany, Austria, Hungary, Denmark, United States, Great Britain, India, Roumania, Russia, Servia, Switzerland).

#### INFECTED SHIPS.

82. Infected ships will be subjected in the ports of the Mediterranean to the general rules applicable to infected ships at the port of arrival.

Adopted by 12 votes against 2 (Spain, Mexico), and 7 abstentions (Brazil, Denmark, United States, Great Britain, India, Russia, Turkey).

U.—When ships arrive in the Mediterranean the measures to be taken will differ when Europe is free from cholera from those to be taken when cholera already prevails.

In the first case, when the disease only prevails upon the southern shores of the Mediterranean, large vessels coming from one of the infected points upon this shore will be subjected, upon their arrival, to an isolation of seven days, including the duration of the voyage.

In the case of small vessels the duration of the voyage will not be included in the period of isolation. This will be for seven full days. The local sanitary authority may, however, reduce this period to three days when the prescribed measures of sanitation have been observed at the port of departure and during the voyage.

Rejected by 10 votes (Germany, Austria, Hungary, Brazil, Spain, Great Britain, India, Mexico, Sweden, Norway) against 7 (Denmark, France, Italy, Holland, Portugal, Roumania, Servia), and 4 abstentions (United States, Russia, Switzerland, Turkey).

V.—(a) When cholera is in the countries of the Mediterranean outside of Europe, and Europe is yet free from it.

#### SUSPECTED SHIPS.

Ships having had a voyage of more than ten days will receive free pratique at once if during this time there has been no suspicious case of sickness or death on board, and if the medical inspection shows that the measures of sanitation and disinfection have been vigorously executed at the point of departure and during the voyage.

If the voyage has lasted less than ten days, but more than five days, free pratique will only be accorded after an observation of twenty-four hours, during which the exact sanitary condition of the passengers and crew will be verified, and soiled linen will be disinfected.

If the voyage has lasted less than five days, the passengers and crew will, according to the advice of the physician, be isolated from two to five days, and disembarked if it is possible; during this time the exact sanitary condition of the passengers and crew will be verified, and soiled linen will be disinfected. The ship will be cleansed, and, as far as possible, disinfected.

#### INFECTED SHIPS.

Infected ships will be subjected, in the ports of the Mediterranean, to the general regulations applicable to infected ships at ports of arrival.

(b) When cholera exists already in the European countries of the Mediterranean.

If cholera prevails only in certain localities, far removed from the port of arrival, either by land or water communication, the measures indicated in article *a* will be enforced.

If the disease prevails in a locality so near the port of arrival that communication is easy and direct, then the measures applicable to land routes should be applied.

Rejected by raising of hands.

#### SPECIAL MEASURES FOR THE SEA OF MARMORA AND FOR THE BLACK SEA.

##### SUSPECTED SHIPS.

X.—The passengers and crew will be landed at an isolated locality. This isolation will last ten full days.

##### INFECTED SHIPS.

Infected ships will be subjected, in the ports of the Sea of Marmora and of the Black Sea, to the general rules applicable to infected ships at ports of arrival, but the isolation will be for ten days.

Rejected by 6 votes (France, Italy, Holland, Russia, Sweden, Norway) against 5 (Spain, Mexico, Roumania, Servia, Turkey), and 10 abstentions (Germany, Austria, Hungary, Brazil, Denmark, United States, Great Britain, India, Portugal, Switzerland).

#### SANITARY PROPHYLAXIS FOR THE CASPIAN SEA.

83. The measures established for the other seas will suffice also for the Caspian Sea.

Adopted unanimously.

#### III.—SANITARY PROPHYLAXIS AGAINST YELLOW FEVER.

84. The measures recommended against cholera are, in general, applicable to yellow fever and to other diseases which prevail in epidemic form under the influence of bad sanitary conditions, and which are transmitted by human intercourse.

The most effective measures for preventing the propagation of diseases of this class are:

The sanitary improvement (*assainissement*) of cities and of vessels sailing from infected ports, isolation of the sick, and disinfection of infected or suspected articles and localities.

#### ANALYSIS AND COMMENTS.

An analysis of the foregoing votes of the technical committee of the International Sanitary Conference of Rome, 1885, shows that in many points the action of the accredited delegates was far from unanimous, whilst in many important matters there was, on the contrary, very little diversity of opinion. By reference to this analysis it is seen that not a few of the determinations of this committee were arrived at by less than an actual majority of the whole committee.

Thus it is apparent that—

Sections 2, 3, 5, 7, 8, 9, 11 to 17, 19, 20, 23 to 38, 52 to 58, 60–63, 66, 67, 71, 72, 78 were adopted with practical unanimity.

Sections 1, 6, 21, 30, 39, 42 to 48, 50, 51, 59, 65, 68, 73, 76, 77 were adopted by a large majority of the whole number of delegates.

Sections 49, 64, 69, 70, 74, 82 were adopted by a mere majority of the whole number of delegates.

Sections 10, 18, 22, 75, 79, 80, 81 were adopted by an actual minority of the whole number of delegates.

Sections F, H, I, M, N were rejected by a large majority of the whole number of delegates.

Sections A, B, C, G, K, L, O, P were rejected by a mere majority of the whole number of delegates.

Sections D, E, Q, R, S, T, U were rejected by an actual minority of the whole number of delegates.



In the case of the adoption of sections 22, 80, and 81, the delegates abstaining from voting outnumbered those voting with the majority; and the same was true of the rejection of sections E, S, T.

Two points are especially noteworthy in the conclusions of the technical committee, namely: First, the admissions expressed in section 4; Second, the declaration embodied in section 6.

The language of section 4 is unequivocal in the affirmation that "General sanitation and *isolation, real and complete*—in the measure indicated by science—*of everything which might introduce the disease*, are the best means of preventing the importation and propagation of cholera." (Italics mine.)

Section 6 declares that "Land quarantines and sanitary cordons are useless."

When these two sections are placed side by side it is obvious that the principal basis of the one is strongly antagonized by the verbiage of the other.

In numerous places in this report, I have endeavored to point out the absurdity of the usual basis of the arguments advocating the complete abandonment of land quarantines and *cordons sanitaires* in the choice of means of defense against the invasion and the advance of cholera. I have endeavored also to show that the results of *even the farcical attempts* at the establishment of land quarantines and *cordons sanitaires*, so frequently made in the past by those combatting the spread of this disease, have been productive of much benefit—sometimes in arresting, oftentimes in impeding the onward course and destructiveness of the epidemic.

There is one other important point concerning the conclusions of this committee of the International Sanitary Conference of Rome to which I would direct especial attention. It will be seen by reference to the foregoing protocol, that in the matter of granting free *pratique* without delay to ships or steamers from or touching at suspected or infected ports, the declarations of the ship's officers and of the ship's log as to the absence of infectious disease during the voyage and at the port of departure shall, to a great extent, determine or influence the action of the hygienic officials at the port of arrival as well as at the proposed points of international quarantine *in transitu*. The history of the introduction of cholera into Arabian ports by East Indian pilgrim ships in 1881, 1882, and 1883; the history of the course of cholera on board H. M. S. *Crocodile* in 1884; the history of the introduction of cholera from Italy into South America by the emigrant steamer *Perseo*; the history of the conveyance of cholera from Italy to the port of New York in 1887 (related in this report); and the history of numerous similar occurrences in the past, all prove the frequent practice of deliberate falsification of the sanitary records of ship's crews and passengers for the purpose of evading quarantine regulations.

These histories, in my opinion, demonstrate the folly of trusting to this class of evidence in determining how soon free *pratique* shall be granted and how long quarantine or observation shall be undergone. Under the widely varying local hygienic conditions existing among the various nations, pointed out in this report, one set of sanitary measures of defense against cholera for all would seem to be extremely difficult to devise or universally enforce. It is very certain that a system of prophylaxis against cholera, based mainly upon good local hygiene and excellent organization of efficient local sanitary boards to the exclusion of quarantines, isolation, and surveillance, such as may be a safe reliance in England, would be very dangerous for enforcement in Egypt or Spain, for example. In fact, the suggestion of the late Professor Maragliana, already mentioned, that international sanitary agreements may be beneficial and practicable in providing for the general defense of Europe against invasions of cholera by way of the Red Sea and the Suez Canal, but can not be depended upon by individual European nations as a reliable means of defense against an invasion of cholera from another European nation, especially a neighboring one, is, in my opinion, worthy of deep consideration.

An attempt to ignore the bearing upon prophylactic measures against cholera of the essential differences in local hygienic conditions which actually exist and are incapable of removal for decades to come (even if earnest efforts should be made in that direction) could not but prove disastrous if it should be practically made. The defense of individual nations, as well as of particular localities, can be successfully accomplished only by having due regard both to the nature and habits of the enemy and to the special peculiarities of weakness and of strength of the jeopardized or assailed.

It will perhaps have been noticed by the reader that section 58 of the protocol, which was unanimously adopted, thoroughly indorses and recommends for adoption by other nations "all the measures adopted by the British Government in India relating to the embarkation and transportation of pilgrims from India on the Red Sea." If it be true that, "By their fruits ye shall know them," these measures should rather be condemned than followed as a model. It is certain that, notwithstanding these unanimously commended "measures," cholera has been for the last decade carried by British ships almost annually from the port of Bombay to some of the ports of Arabia. For some of the reasons of this frequent transportation of cholera from India westward the reader may consult previous pages of this report. Perhaps a safer guide for the rest the world might be the application of the principles of prophylaxis against cholera, which may be deduced from the standing regulations for the management of cholera among the Indian army, and from the general sanitary instructions to East Indian villagers, already mentioned. These regulations and instructions were not drafted for the protection of the world but were especially conceived for the benefit of British subjects in cholera-stricken India.

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*SANITARY REGULATIONS IN ITALY, PROMULGATED IN 1887.*

The United States minister at Rome, in his dispatch to the Department of State, dated September 14, 1887, incloses a copy of a circular order recently issued by the Italian Minister of the Interior to prefects, on measures to be taken in the communes of that country to prevent the diffusion of cholera. The circular contains twelve paragraphs. Nos. 1 and 2 are as follows:

(1) Whenever, in any commune of the kingdom, a sanitary officer recognizes individuals affected with cholera he must make immediate annunciation of it to the mayor of the place, accompanied in the first instance, with written declarations specifying the symptoms on which his judgment is founded. The mayor will then transmit the annunciation to the prefect, and whenever, in the first instances, there appears doubt as to the nature of the disease, a sanitary officer skilled in bacteriological research shall be called to decide.

(2) In the mean time, on the declaration of the sanitary officer regarding the choleraic nature of the disease, the communal authorities shall immediately take the steps here below indicated to prevent infection of others, at the same time giving to the sick all necessary care, according to the gravity of their condition. Such steps shall consist essentially in isolation of the sick, measures of precaution for persons attending them, destruction or thorough disinfection of dejections, vomits, linen, clothing, bedding, and other articles subject to contamination.

A.—Isolation of the sick may be obtained by keeping them at home (sending away all healthy persons not strictly necessary for their assistance) or conveying them to a special place of isolation previously prepared by the commune. In the second instance, transportation of the sick must be by special carriages or stretchers, which shall be thoroughly disinfected after each use by abundant washing and solutions hereinafter indicated.

B.—As a precautionary measure for persons assisting cholera patients, first of all they should be informed that there is no danger of infection by contact, or by living in the same room with the sick, provided their hands and clothing are not soiled by fecal and vomited matter. They will be advised, however, to wash their hands frequently in disinfectant solutions, especially before taking food, and to subject their clothing to the same washing whenever they may have reason to fear it may be contaminated. To this end the patients' rooms will be furnished with a sufficient quantity of corrosive sublimate dissolved in water, in proportion of 2 per 1,000, kept in non-metallic receptacles. To avoid danger of mistakes, this corrosive sublimate mixture will be lightly tinged with aniline or a vegetable color. When corrosive sublimate can not be obtained, solutions of phenic acid, in proportion of 5 to 100, or sulphuric or hydrochloric acid, of 5 per 1,000, or other liquid acids may be used.

C.—The dejections of the sick shall be received in basins having an abundance of disinfecting solution. If possible, this latter should be composed of corrosive sublimate, as above.



In no case shall these dejections be thrown into streets, courts, or upon dung-hills; they shall be deposited in places apart, or in water-closets, where it is certain they can not contaminate water. Basins which have contained dejections shall be washed with the above-named solutions. Wherever dejections may be deposited, there shall be thrown abundant quantities of these disinfectants, or of chloride of lime, in proportion of 5 per 100.

D.—Linen, woolen, clothing, shoes and stockings, and bedding used by the sick, or in any way soiled by dejections or vomit, should be destroyed by fire in preference to any other means of disinfection, above all in first cases, even when not followed by death. Whenever, for economical reasons, this may be impossible, and where no apparatus exists for disinfection by steam, disinfection is to be preferred by immersion from ten to fifteen minutes in a solution of corrosive sublimate, in proportion of 2 per 1,000. In case this latter can not be done, the articles should be immersed for one and a half hours in water kept boiling. All articles and effects, even after disinfection, shall be washed again separately from those belonging to the healthy, and, if possible, in separate laundries. Articles used by cholera patients should be disinfected singly and as they become contaminated, the accumulation of such soiled articles being very dangerous.

E.—After the death or recovery of a patient, a rigorous disinfection of the room and articles contained will be made immediately, and before occupation by healthy persons. Therefore the articles in question shall be washed with the same solution, corrosive sublimate, as well as the floor and walls to the height of  $2\frac{1}{2}$  meters (8 feet), the whitewash to be removed and renewed. Beds and mattresses will, in general, be burned; but where it is desirable to preserve them they shall be taken apart and the ticking and filling separately disinfected with a solution of corrosive sublimate, as before indicated, at 2 per 1,000.

F.—When the death of a cholera patient has been verified by the examining physician, the remains shall be transferred as soon as possible to the mortuary chamber, there to be kept under observation for the period fixed by the sanitary regulations. This transfer shall be made in a coffin of wood, the remains being wrapped in cloth saturated with the usual solution of corrosive sublimate. Frequent opportunities for washing in the above-mentioned disinfecting solution shall be given to persons employed in sepulture.

G.—The burial or cremation of remains of cholera patients shall be under the usual precautions pertaining to other infectious diseases. It is unnecessary, except for reasons of space, to establish separate cemeteries, and there is no objection to such remains being interred in private plots and tombs. Nevertheless burial in the so-called common pits (*fosse carmarie*) is rigidly prohibited.

## CHAPTER VIII.

### THE ETIOLOGY, PATHOLOGY, SYMPTOMATOLOGY, PROGNOSIS, AND TREATMENT OF CHOLERA INFECTIOSA OR ASIATICA.\*

#### SECTION 1.

##### NATURE, CLINICAL FEATURES, THERAPEUTICS, ETC.

*Definition.*—Cholera infectiosa or asiatica is an infectious disease of a specific character, due to a specific agent, a living parasite, which primarily attacks the intestinal canal. This agent is transportable from place to place, and is endowed with the power, under favorable circumstances, of rapid multiplication, both within and without the human organism.

The infecting agent exists in the intestinal contents of those suffering from the disease, and is discharged with the alvine evacuations, and sometimes also with the ejections from the stomach. Both dejecta and ejecta, hence, contain the infectious principle, and under favorable circumstances are capable of conveying the disease, either directly or indirectly, from the sick to the healthy. *Cholera asiatica is, therefore, an infectious disease, and is capable of being conveyed from person to person and from place to place, and, under favorable circumstances, of becoming epidemic.* It should, consequently, be properly named *cholera infectiosa*.

It is usually characterized by a sudden onset and rapid course, often preceded by certain premonitory disturbances of the intestinal canal; copious alkaline and painless alvine evacuations of a rice-water, macaroni-water, or meal-gruel aspect, holding in suspension desquamated flakes of the epithelial lining of the intestines; great prostration; cold, livid, shrunken skin; cold, clammy sweat; cold, livid tongue and hollow eyes; huskiness and weakness of the voice; shallow respiration; weakness of the action of the heart accompanied by sluggish circulation of the blood and weakness or absence of the carpal pulse; painful cramps of the extremities and trunk, and a high mortality.

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#### SECTION 2.

##### ETIOLOGY AND PATHOLOGY.

Cholera infectiosa has, as a specific exciting cause, a specific infecting agent, which enters the person attacked by way of the stomach.

This agent is in all probability a vegetable parasite—namely, the comma bacillus of Koch. In the process of development and growth of this parasite, both within and without the human body, a specific poison or *ptomaine*—a chemical alkaloid possessing specific chemical and physiological properties—is produced; the primary action in the human system is upon the mucous

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\* Nearly the whole of this chapter has appeared in another form in two articles contributed to Keating's *Cyclopedia of the Diseases of Children*, vol. 1, by the writer. The matter of those articles as well as most of the illustrations accompanying them were prepared for this report.



membrane of the intestinal canal, chiefly the small intestine, and the ultimate result is the desquamation and destruction of the epithelial elements.

The poison elaborated in the intestines is absorbed, produces an inflammatory irritation of the tissues immediately underlying the epithelia, and finally enters the circulating blood. In the blood it attacks the red corpuscles, causing destruction of some and alteration of the function of many, and it causes great disturbances of the nervous system, the gravity of its effects falling principally upon the vaso-motor and respiratory centers.

This infecting agent, that is the vegetable parasite, exists in the alvine discharges and the vomited material of persons suffering an attack of cholera infectiosa, and is capable, under favoring circumstances, of passing again into a human host and producing the disease.

For a more complete discussion of the etiology and pathology of this disease reference is made to chapter iii of this report.

The mode of infection and prophylaxis of cholera infectiosa are somewhat fully considered in sections 3 and 4, chapter vii, of this report.

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### SECTION 3.

#### SYMPTOMATOLOGY.

The symptoms met with in cholera infectiosa are extremely varied, according to the stage and the character and rapidity of the attack. Clinicians who have treated of this disease have generally recognized four stages: *a*, of premonitory diarrhœa; *b*, of serous diarrhœa; *c*, of collapse, algidity, or asphyxia; *d*, of reaction.

(*a*) As to whether the premonitory diarrhœa is to be properly regarded as the actual commencement and an essential part of the disease, or whether it is to be considered as a frequent predisposing simple disorder of the digestive apparatus, opinions have differed, and experienced physicians are still far from harmonious. Whilst in most epidemics of cholera perhaps the majority of sufferers experience the so-called premonitory diarrhœa, yet observers have repeatedly noted its general absence. And, again, where such diarrhœas have been widely prevalent, common experience has shown that only a comparatively small percentage develop into recognized choleraic attacks. If the premonitory diarrhœa indicates a genuine invasion of the organism by the specific infection of the disease, certain it is, nevertheless, that there are many grave and even fatal attacks without its presence. But it is in the experience of all who have had much to do with epidemics of cholera that any one of the recognized stages of the disease may be wanting. It therefore seems unwarrantable, on the ground of its frequent absence, to exclude the first stage of premonitory diarrhœa as a part of the real disease. And from the stand-point of therapeutics it is wise to treat this stage as the commencement of an attack of cholera, which if neglected at this time may ultimately have a fatal termination. If not controlled, the diarrhœa may, after persisting for hours or days, be followed by the onset of symptoms which remove all doubt, during the existence of an epidemic, of the commencement of an attack of the dreaded disease. It is during the night that this onset occurs in the majority of cases.

(*b*) Serous diarrhœa is the symptom which, with its usual accompaniment of intense thirst, nausea or vomiting, cold, shrunken, wrinkled skin, sunken eyeballs, husky voice, cold tongue, weak, frequent, thready pulse, great prostration, restlessness, anxiety, and cramps, by far the most frequently marks both for the family of the sufferer and for the physician the commencement of the feared attack. If diarrhœa has been present, the alvine evacuations undergo usually a striking and more or less characteristic change, as well as often become much more copious and frequent. Up to this point the disease has been essentially localized, and the intensity of action of the specific poison has fallen upon the lining of the intestinal canal. The intestinal epithelia lose their functions and vitality and desquamate in flakes. Probably even before this the specific poison has reached the circulation and induced a

paralysis of the intestinal capillaries and venules. With the desquamated flakes of epithelia the lumen of the intestine now contains serous fluid exuded from the paralyzed capillaries. The intestinal contents are free of bile, resemble a more or less thick meal-gruel or macaroni- or rice-water, and the alvine evacuations present the well-known appearance of such material, but often somewhat foamy, and they are strongly alkaline in reaction. Besides the symptoms above indicated, any of which may be wanting or but little pronounced, there is now more or less suppression of urine. This symptom has by some authors been ascribed to a mechanical effect of the enormous exudation of the fluid of the blood into the intestinal canal. But there is a pathological state of the secretory elements of the kidneys now present which is closely analogous if not identical to that existing in many of the infectious fevers, and it is highly probable that the suppression of urine is in great part the result of the poisonous action upon the kidney of the specific ptomaine contained in the blood.

Whilst serous diarrhœa is customarily an exceedingly prominent symptom in cholera infectiosa, yet there are genuine cases of the disease where it is totally absent—the so-called cases of *cholera sicca*, dry cholera. In these cases, although there may be no diarrhœa at all, the autopsy shows almost invariably an enormous quantity of the grumous fluid retained in the intestinal canal which it distends. Moreover, the characteristic aspect of the intestinal contents and alvine discharges above described is by no means invariable; instead of a colorless material there may be a yellowish or even a bloody tinge, and there may be a certain admixture of ordinary intestinal contents. The intellect is generally clear.

(c) The stage of serous diarrhœa or of rice-water discharges from the bowels, with the accompanying symptoms, lasts for a variable period of two or three to several hours. Reaction may occur at the end, or, as is more frequently the case, collapse may set in. In this stage the vomiting ceases, the serous discharges are interrupted, or the contents of the intestines dribble away unceasingly and involuntarily. The heart almost stops its pulsations; the thickened blood almost ceases to flow; respiration becomes extremely shallow, slow, and irregular; aphonia is complete, as also is anuria; the surface is cold as marble, and livid, especially that of the orbit, nose, lips, fingers, and toes. Even the tongue and the breath are cold. This stage may last for several hours, to end in death or reaction.

Although the surface temperature, as estimated by the hand or by the ordinary application of the surface thermometer, is usually below the normal, both in the stage of serous diarrhœa and in that of collapse, the temperature of the rectum is actually higher than in health, and in some cases is greatly elevated. Indeed, notwithstanding the striking coldness of the cutaneous surfaces, at times cadaveric, the patient is usually sensible of the most consuming internal heat. And if death supervene during these stages, the temperature of the corpse may ascend several degrees above the normal body-heat and remain there for some hours. Another post mortem phenomenon, which is sometimes startling to the uninitiated, is the not infrequent occurrence of marked muscular contractions of the muscles of the face and extremities, productive of various facial contortions and movements of the limbs after death.

(d) The stage of reaction succeeds that of serous diarrhœa or of collapse. In the most fortunate cases convalescence begins at once and proceeds regularly to the rapid restoration of health, with the appearance of bile and of normal fæces in the intestinal canal. But if destruction of the intestinal epithelia and involvement of the subjacent connective tissue of the mucosa have been extensive, or if the formed elements of the blood have seriously suffered, as not infrequently happens, especially in the so-called toxic form of cholera, one of three issues may follow: there may be prolonged anemia with all its usual sequences; or there may be a long-continued series of digestive derangements, and in either case a very tardy re-establishment of health; or the denuded and inflamed intestinal surfaces may afford entrance to septic germs, and the unfortunate patient pass from the active choleraic seizure into a scarcely less dangerous typhoid condition of reactionary septic fever.

During the stage of reaction numerous and extremely varied cutaneous manifestations have been frequently noted. A few authors have also recorded the occasional occurrence of various cutaneous eruptions during some of the earlier stages of the disease, even during that of premonitory diarrhœa.



According to the character, gravity, and rapidity of the attack, besides those already noted, various qualifying terms have been employed in the description of cholera, among which the principal are *cholérine*, *cholera foudroyante*, *cholera toxica*. By *cholérine* is meant an exceedingly mild form of the infectious disease, without the development of the stage of collapse or of typhoid reaction. The term *foudroyante* is applied to those exceedingly rapid and grave cases which run their frightful course from beginning to end in a very few hours. In *cholera toxica* there seems but little evidence of localization of the initial attack upon the intestinal canal; but the nervous centers and the great internal organs are quickly overwhelmed with toxic quantities of the poison.

#### RISE OF TEMPERATURE IN CHOLERA.

I deem it advisable to subjoin here the following accounts of new observations made during the last visitation of Europe by cholera, relating to the temperature of the attacked, and I am led to do so by a suggestion of Dr. J. M. Da Costa, which I quote from a letter recently received from that distinguished clinician:

"I have often thought that the temperature record might be valuable, but I am not aware of its having been closely studied."

E. DE RENZI, in discussing the *temperature* of cholera, says (Sul colera di Napoli. Rivista clinica e terapeutica, No. 2, 1883):

Another proof, and perhaps the most convincing of all, in the demonstration that cholera is an infectious, general disease, is found in the results of thermometrical observations collected by me during the last epidemic. I may be permitted to add, in this connection, that in all the books and monographs upon cholera it is always admitted that this disease is not only a febrile, but is even accompanied, on the contrary, by a notable lowering of the temperature, which is regarded by every one as characteristic of grave cholera.

It is true that a few observers have at times found the temperature more elevated than normal; that they have met with this phenomenon near death; that Güterbock has found a sensible difference, as much as 3.7° C., between the temperature of the axilla and that of the rectum. But it is always held that such increase is, in fact, exceptional; and it is explained either by diminished loss of heat in the skin, by difficult respiration, or by the period of reaction having supervened upon that of algidity. But, in general, it is always held as axiomatic that the temperature falls in cholera from two to three degrees, and sometimes even to a greater amount.

If, indeed, one were to avoid a pregnant source of error, such as the slowing of the circulation in the skin, and the apparent lowering of the temperature at the surface of the body, he would recognize with facility, as all my observations demonstrate, that in cholera patients the thermometer, *well applied*, constantly registers higher than normal. Scarcely did I recognize this fact, which is in discord with the general belief, before I hurriedly gave notice of it to my colleagues of the Mercato district (Naples), in order that the unbiased experience of others might afford a proper check to the results of my researches. And the studies of Profs. Pellacchia, Mesolella, Jervolino, Stampa, *et al.*, fully confirm the rise of temperature in cholera patients.

In these patients thermometric observation is very difficult. The gravity of the disease, the restlessness of the patient, the frequency of the evacuations, the necessity for keeping the thermometer applied in the axilla for 10 minutes *at least*, a quarter of an hour, more often for a half hour and even longer, render the observation sufficiently troublesome, and sometimes quite impossible. On account of the coldness of the skin, a considerable time elapses before the equilibrium of the thermometer between the walls of the axilla and the interior of the body is established.

But, overcoming all the difficulties and performing the thermometrical researches with the necessary precision, this is what is found in cholera patients: The temperature of the axilla is constantly elevated in cholera patients above the physiological level. This rise, at first insignificant, increases with the progress of the disease to such an extent as to reach, in grave cases, and after a few hours, often 39° and even 40° C. This febrile temperature is due to

the cholera *per se*, and not especially to the typhoid-cholera. In effect, it is even observed in the so-called cholérine, and still in the algid form of cholera; but in this last it may be more marked. Although in asphyxic cholera, and when the cutaneous surface gives a disagreeable impression, as if one were touching the skin of a reptile, the degree of heat indicated by the thermometer is notably greater than the physiological. This rise, then, is evidently, therefore, not due to the drying up of the skin and failure of cutaneous evaporation; but it owes its origin to the nature of the morbid process. In fact, in cholera patients with whom the skin is kept moist and warm by the bath, warm clothing, etc., the rise of temperature is met with in the same manner. Therefore, as a general conclusion, it may be affirmed from these studies that cholera, like all the other infectious and acute diseases, is constantly associated with a febrile elevation of temperature.

MONTEFUSCO relates as follows the results of "clinical researches concerning the *temperature of cholera*," made by him at the Conocchia Hospital (Naples) during the cholera epidemic of 1884:

Little exact knowledge is possessed concerning the temperature of cholera. This paucity of observations depends in great part upon the difficulty and delicacy which the examination of the temperature in this disease requires on account of the danger and great suffering of the patients. To this it should be added that in order to obtain reliable results of the temperature in cholera, it is necessary to keep the thermometer applied a long time, ordinarily more than half an hour, for, as first noted by Baerensprung, the column of mercury, at the maximum in the algid period, rises very slowly.

I occupied myself with this subject at the Conocchia Hospital, and I repeated upon a large scale observations concerning the temperature which in many patients I could follow through all the stages of the disease.

In the prodromic period notable changes of temperature were never observed. In the majority of cases in this stage, the temperature remains within normal limits, very infrequently it may be increased at most only a few tenths.

Great elevations of the temperature I have noticed in those benign forms of choleraic infection which readily yield to opiates and tannic acid without being followed by a grave attack of cholera. In many of these cases the axillary temperature is raised as high as  $36^{\circ}$  and  $38.5^{\circ}$ , there being almost always an increase in the evening from one tenth to half a degree.

In the stage of asphyxia the lowering of temperature of the exterior of the body is a phenomenon among the most notable and constant. In general the falling of the temperature is not equal over the whole surface of the body; the maximum of coldness I have always noticed in the face and other exposed surfaces, while in the trunk there is never seen a very marked lowering of temperature.

No constant relations have been observed between the temperature of the extremities and that of the axilla which in many patients remains notably elevated. I particularly remember a case worthy of note in which, while the temperature of the extremities was many degrees below the normal, the temperature of the axilla indicated  $38.6^{\circ}$ . In many other patients I witnessed a considerable augmentation of the axillary temperature, from  $38^{\circ}$  to  $39^{\circ}$ , and  $39.5^{\circ}$  C.

Again in all cases in which the axillary temperature descended below the normal, this falling of the temperature always followed after the whole surface of the body was completely chilled; the algidity advancing almost constantly from the lower extremities to the higher.

The maximum fall of temperature observed in the Conocchia Hospital was noted in a patient of Dr. Orazio Caro; the thermometer applied to the axilla for more than three quarters of an hour marked only  $31^{\circ}$ .

In many cases I could see a close relation between the falling of the external temperature of the body and a marked increase of the vomiting and the diarrhoea. In general, the lower temperatures are met with in the cases in which the fluids lost by vomiting and purging have been very striking. Studying in many patients the temperature during the different hours of the day, I was able to observe almost constantly a remittent type—the temperature of the evening being always more elevated than that of the morning, sometimes only a few tenths of a degree, at others a half degree or more. In few cases, however, I noticed in the temperature



curve oscillations in an order inverse to this—namely, a slight increase in the morning hours. I have taken many times the internal temperature of the body, applying the thermometer in the rectum, and in women also in the vagina. Below are some clinical histories of patients in whom I have made comparative observations between the axillary temperature and that of the interior of the body.

*Observation 1.*—M. G., aged 18, from Lipari; received at the hospital at 10 a. m.; 16th of November had profuse vomiting and characteristic diarrhœa; epigastric pain, which increased upon pressure; painful cramps in the muscles, cyanosis of the lips and of the hands, weak pulse, great prostration of strength; the axillary temperature  $38.9^{\circ}$ , rectal temperature,  $38.8^{\circ}$ ; at 6 p. m. axillary temperature  $35.9^{\circ}$ , rectal temperature  $39^{\circ}$  C.

September 17, vomiting is arrested by hypodermic injections of chloride of morphia; the diarrhœa much diminished, following the use of tannic acid alternating with clysters.

At 8 a. m. axillary temperature,  $35.7^{\circ}$ ; rectal temperature,  $38.7^{\circ}$ . At 1 p. m. axillary temperature,  $35.8^{\circ}$ ; rectal temperature,  $38.7^{\circ}$ . At 6 p. m. axillary temperature,  $36^{\circ}$ ; rectal temperature,  $38.8^{\circ}$ .

*Observation 2.*—N. N., entered the hospital the 18th of September; had vomiting, diarrhœa, epigastric pain, anuria, intense cyanosis, prostration, pulse imperceptible.

Axillary temperature at 10 a. m.,  $37.4^{\circ}$ ; rectal temperature,  $39^{\circ}$ . At 5 p. m. axillary temperature,  $37.2^{\circ}$ ; rectal temperature,  $39.2^{\circ}$ . September 19, at 8 a. m. axillary temperature,  $39.2^{\circ}$ ; rectal temperature,  $39.7^{\circ}$ ; 6 p. m. axillary temperature,  $37.2^{\circ}$ ; rectal temperature,  $39.5^{\circ}$  C.

*Observation 3.*—N. N., admitted October 4; had vomiting, diarrhœa not very abundant, epigastric pain, muscular cramps, cyanosis, prostration, imperceptible pulse. The general condition not in proportion to the slight amount of diarrhœa.

At 11 a. m. axillary temperature,  $35.2^{\circ}$ ; rectal temperature,  $39.6^{\circ}$ . At 7 p. m. axillary temperature,  $35.5^{\circ}$ ; rectal temperature,  $37.7^{\circ}$  C.

The 5th of October a sensible amelioration in the general condition is noticed; hypodermic injection of quinia and aromatic spirits of ammonia continued.

At 7 a. m. axillary temperature,  $35.6^{\circ}$ ; rectal temperature,  $38.8^{\circ}$ . At 12 m. axillary temperature,  $35.6^{\circ}$ ; rectal temperature,  $38.9^{\circ}$ . At 6 p. m. axillary temperature,  $35.9^{\circ}$ ; rectal temperature,  $38.9^{\circ}$  C.

*Observation 4.*—N. N., admitted 4th of October; had profuse diarrhœa and vomiting for several days; epigastric pain, muscular cramps, anuria, very intense cyanosis.

At 3 p. m. axillary temperature,  $35.2^{\circ}$ ; vaginal temperature,  $39.7^{\circ}$  C.

October 5, clysters of tannic acid and injections of quinia; the vomiting and diarrhœa are markedly diminished.

At 8 a. m. axillary temperature,  $35.5^{\circ}$ ; vaginal temperature,  $39^{\circ}$ . At 12 m. axillary temperature,  $35.4^{\circ}$ ; vaginal temperature,  $39.7^{\circ}$ . At 6 p. m. axillary temperature,  $35.7^{\circ}$ ; vaginal temperature,  $39.2^{\circ}$  C.

October 6, Vomiting is arrested and diarrhœa ceased almost entirely; hypodermic injections of quinia and of sulphuric ether are performed.

At 8 a. m. axillary temperature,  $36.3^{\circ}$ ; rectal temperature,  $38.7^{\circ}$ . At 6 p. m. axillary temperature,  $36.7^{\circ}$ ; rectal temperature,  $38.2^{\circ}$  C.

*Observation 5.*—N. N., admitted 5th of October; had vomiting, with profuse and obstinate diarrhœa; epigastric pain, which increased extraordinarily upon pressure; painful cramps, complete anuria, and prostration.

At 2 p. m. axillary temperature,  $37.2^{\circ}$ ; rectal temperature,  $39.5^{\circ}$  C.

October 6, diarrhœa is almost entirely overcome by large clysters of tannic acid; the general condition but little changed.

At 8 a. m. axillary temperature,  $36.8^{\circ}$ ; rectal temperature  $39.4^{\circ}$ . At 6 p. m. axillary temperature,  $37^{\circ}$ ; rectal temperature,  $39^{\circ}$  C.

From my observations, it appears that the temperature of the interior of the body in the algid stage of cholera is almost always more elevated than the normal. This elevation of the temperature of the interior of the body, ordinarily quite notable, stands certainly in relation with the sense of burning heat and internal itching which almost always torments the patients in this stage.

Usually between the temperature of the interior of the body, as taken in the rectum or in the vagina, and that in the axilla, or still more, that of the rest of the surface of the body, there exists always a great disproportion, but we are unable, however, to establish between the two temperatures any constant relation. Besides the example cited I have very frequently noticed a rectal temperature of  $38.7^{\circ}$ ,  $39.2^{\circ}$ ,  $39.9^{\circ}$ ; while the axillary temperature was only registered at  $34.3^{\circ}$  and  $35.5^{\circ}$  C.

This disproportion between the axillary temperature and that of the natural cavities gives a great value to the hypothesis of Lebert, that in the algid stage of cholera we have to deal with an irregular distribution instead of a general loss of heat, which accumulates in the interior of the body, while at the periphery, and especially in the extremities, it is continually lost in great quantity.

But this interpretation can not be accepted unqualifiedly, because in some cases the internal temperature descends below that of the normal. I have remarked a few times such a lowering of the internal temperature. In the patient S.L., admitted to the hospital 29th of September, dead on the 5th of October, I observed the lowest rectal temperature  $35.5^{\circ}$ , whilst the axillary was  $35.2^{\circ}$ . I remember other rectal temperatures below the normal:  $35.9^{\circ}$ ,  $36.2^{\circ}$ ,  $36.7^{\circ}$ , corresponding respectively to the axillary temperatures of  $35.8^{\circ}$ ,  $36.3^{\circ}$ ,  $36^{\circ}$  C.

In these cases the cause of so notable a falling of temperature can not be solely due to dispersion of heat; it must have to do rather with less production of heat, which is undoubtedly to be attributed to profound disturbances of innervation.

My observations concord in general with almost all the others which have been previously made concerning the temperature in the rectum and in the vagina.

Already as early as 1855 Zimmermann (Deutsche Klinik) had seen the rectal temperature rise during the algid stage, whilst that of the axilla remained very low.

After him Mackenzie, Charcot and Güterbock studied the internal temperature during the algid period of cholera.

In two observations of Mackenzie (London Hospital Reports, 1886), made at nineteen hours' interval upon the same patients who got into a very grave condition, the temperature of the vagina at the first observation was  $39^{\circ}$ , at the second, when the cyanosis had already diminished, it was  $38^{\circ}$ ; the axillary temperature, on the contrary, was, at the first observation,  $32.5^{\circ}$ , at the second observation,  $35.5^{\circ}$  C.

Charcot (Sur la température du rectum dans le cholera. Gaz. Med. de Paris, 1886) made observations upon ten patients. In all the cases, except in one, the introduction of the thermometer into the rectum showed either that the central heat was sensibly increased or at least that it had not fallen below the normal. In three cases the axillary temperature was  $37^{\circ}$ ,  $37.8^{\circ}$ ,  $37.6^{\circ}$ , whilst the corresponding numbers furnished by the rectal examination gave differences from  $1^{\circ}$  to  $2^{\circ}$ .

Güterbock also (Arch. f. path. Anat., 1867), from an examination of forty-five patients, concluded that during the algid period, whilst there is a marked cooling of the surface, the temperature taken in the natural cavities is augmented in a greater number of cases and is normal more rarely.

Roger only, who took the axillary temperature, considering it as representative of the internal temperature, affirms in an absolute manner the contemporaneous diminution of the internal and external temperature, thus reporting the motto of Littre: "Tout est froid chez les cholériques."

After Roger, A. Mignot (Température des cholériques. Gaz. hebdomadaire, 1870) declares that there are no important differences between the axillary temperature and that of the rectum and vagina, supporting himself by the comparison of his results with those of Güterbock, whilst in the charts of his "Traité du cholera morbus," which he invokes as testimony, the following figures are found:  $33.7^{\circ}$ ,  $34^{\circ}$ ,  $35^{\circ}$ ,  $35.2^{\circ}$ ,  $35.4^{\circ}$ ,  $36^{\circ}$ ,  $36.5^{\circ}$  C.; very far from the elevations measured in the majority of the cases with the thermometer in the vagina or rectum.

It is clear that results to which little or no value can be accorded, because of their dubiousness and isolation, cannot overturn the numerous and accurate observations of trustworthy scientists who have studied this question at different times and places with similar results.



I have verified many times the rise of the rectal temperature, as also of the axillary, in the evening hours, but this rise has never been as notable as in some cases with the axillary temperature.

I was enabled to make a few observations upon the temperature in children who were admitted to the hospital. Usually I found increase of the rectal and axillary temperature even to  $39^{\circ}$ ,  $39.2^{\circ}$  C. It has never happened that I have noted normal temperature or subnormal, as Monti states he has seen (*Jahrb. F. Kinderkrankheiten*).

In the stage of reaction from cholera, contemporaneously with the increased strength of the pulse there are marked changes of temperature in the form of regular and complete reaction. The skin recovers step by step its normal heat, accompanied by sweating and varied cutaneous eruptions; at the same time the internal temperature of the body gradually falls.

Usually when an amelioration of all the symptoms of the algid stage begins to appear I have always remarked in the morning the rectal temperature lower than that of the evening, as much as a degree or more; as the amelioration of the other symptoms progresses the evening temperature decreases until it reaches the normal mean.

In the greater number of cases subsequent oscillations have not occurred when, in this form of reaction, the temperature has once returned to the normal. Often, however, during the reaction oscillations continue—sometimes considerable, ordinarily above the normal, but frequently below it.

In the cases of typhoid reaction the temperature has frequently reached  $39.5^{\circ}$ ,  $40^{\circ}$ ,  $40.5^{\circ}$ .

Sometimes during convalescence the temperature has remained elevated for several days, especially in the evening hours.

Ordinarily, at the approach of death, I have observed a rise of temperature, at times very considerable, as much as to  $41^{\circ}$ ,  $41.6^{\circ}$  C. In many cases this rise of temperature is still maintained for some hours after death.

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## SECTION 4,

### DIFFERENTIAL DIAGNOSIS.

During the prevalence of an epidemic of cholera there is usually no difficulty in recognizing an attack if seen in the stage of serous diarrhœa or of collapse. During the stage of typhoid reaction the course of the fever and the state of the nervous system constitute an ensemble of symptoms very closely resembling the typhoid the state of several febrile diseases in which septicæmia plays an important rôle. The typhoid condition in cholera infectiosa is, as has already been mentioned, essentially a septicæmia, but it has usually as complications serious disorders of the liver and kidneys, which more or less influence the type of the fever. The history of the attack, together with the prevalence of the disease, will remove all doubt. As to the stage of premonitory diarrhœa we have already declared that for the purpose of treatment it is always safe to regard it as the beginning of an attack of cholera infectiosa.

But there is always a time in the course of cholera invasions when the difficulty of an absolute diagnosis is very great, if not really impossible, unless recourse be had to the most recent discoveries. Yet, as we have pointed out already, this is the time when for the purposes of prophylaxis an absolute differential diagnosis should be promptly made. The physician is at such times often required to decide between the presence of Asiatic cholera, cholera nostras, pernicious malarial fever, or some form of ptomaine or mineral poisoning. The existence of the comma bacillus of Koch either in the dejecta or in the vomit determines at once the presence of cholera infectiosa; its absence and the presence in the blood of the plasmodium malarix very strongly indicate the existence of malaria. (For an account of the plasmodium malarix and its morphology, consult section 2, Chapter IV, of this report.)

## SECTION 5.

## PROGNOSIS.

The mortality of cholera infectiosa, as is known, is sometimes frightful. During the last it has fallen but little if at all below the percentages of former epidemics. Although the gross number of attacks has lessened, thanks to better hygiene and improved methods of prevention, yet the percentage of deaths to attacks is about the same now as it was many decades ago, and is not essentially lower under modern and civilized systems of therapeutics than it has been under antiquated and semi-civilized or barbarous modes of management. It is usually greatest in the earlier course of the epidemic, and it is limited almost entirely to those who neglect to invoke the aid of the physician until the attack has become exceedingly grave. If the patient is seen early and is promptly, judiciously, and *constantly* cared for, the danger of a fatal issue is not great. If the practice of enteroclysis and hypodermoclysis, as introduced by Cantani, of Naples (see previous pages of this report, as also the following section), meet the claims made for them, the disease will be robbed of many of its terrors.

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## SECTION 6.

## TREATMENT.

Knowledge of efficient methods of treatment of cholera infectiosa has by no means kept pace with that of the etiology and prophylaxis of the disease. Unless the so-called methods of *hypodermoclysis* and *enteroclysis* shall prove as effective as the recent experience of some Italian observers would seem to indicate, there appears to have been no marked advance made in the therapeutics of severe attacks of cholera. In this class of cases the mortality varies from thirty per cent. to eighty or ninety per cent., and seems to be far more influenced by the period and intensity of the epidemic and by hygienic surroundings than by therapeutic interference. It has often happened that the ratio of deaths to the number of pronounced attacks has been nearly as great under the management of skillful and experienced European physicians as in the hands of native East Indian attendants whose chief reliance is upon charms and invocations. Whilst this is true of severe attacks of cholera, nevertheless there is scarcely any grave disease which is more manageable if it be properly and promptly treated during the earlier stages. If the mortality of cases in the later stages often rises above ninety per cent. in spite of active and intelligent interference, judicious management of the disease in the earlier stages is usually followed by as great a percentage of cure or abortion of the attacks.

In the stage of premonitory diarrhœa, absolute rest in bed, with warm clothing and abstention from food, should be enjoined; and appropriate doses of laudanum, either alone or in conjunction with some form of camphor, such as chlorodyne, should be administered; or salicylate or tannate of bismuth may be used. Nearly always this simple treatment will prove efficient.

If, however, the simple diarrhœa persists or shows a tendency to assume the serous type, with or without vomiting, coldness, prostration, and cramps, more vigorous treatment is urgently called for. The body should be enveloped in hot flannels, and heat applied to the extremities; cramps should be combatted by local frictions, either dry or with whisky and salt or the like; vomiting should be checked, if possible, by swallowing small lumps of cracked ice, and by sinapisms applied over the epigastrium. The two remedies which appear to be most efficacious in this stage of the attack are, however, the warm bath and tannic *enteroclyses*. The temperature of the bath should be 38° or 39° C., and the patient should be immersed in it to the chin and kept there for twenty minutes. After removal from the bath the surface should be very quickly dried and enveloped again in hot flannels, and warm aromatic drinks be given. The bath may be repeated *pro re nata* in two or more hours. The effect of the warm



bath, in arresting or allaying the vomiting and in quieting the general nervous system, as well as in restoring warmth to the cutaneous surface, arresting the cramps, stimulating the flagging circulation of the blood, and relieving the general prostration, is often marked to the eye of the observer; and it is usually so comforting to the patient that, although objected to at first, it is frequently called for after being once experienced.

#### ENTEROCLYSIS IN CHOLERA.

The *enteroclysis* of tannic acid introduced by Prof. Cantani, of Naples, and so frequently used by other Italian physicians during the recent cholera epidemic in Italy, would seem to afford the greatest reliance in the treatment both of the premonitory diarrhœa and of the active stages of the disease.

If a slight attack of a seemingly simple diarrhœa does not yield at once to rest in bed and the administration of a dose or two of warm infusion of chamomile to which chlorodyne or laudanum has been added in proper quantity, then recourse should be had without loss of time to the warm *enteroclyses* of tannic acid. This enteroclysis is essentially an injection into the colon, *per rectum*, of a considerable quantity of warm water holding in solution a certain percentage of tannin. The rectal syringe, by means of which the injection is made, is furnished with an elastic tube 3 metres in length with a nozzle at the free extremity and a cock at the proximal end. With such an instrument not only the whole length of the colon can be filled with the desired fluid, but also not infrequently a quantity can be made to pass beyond the ileo-cœcal valve into the small intestine.

The tannic solution recommended by Cantani is constituted for an adult as follows :

R Boiled water or infusion of chamomile, <i>warm</i> .....	2 litres.
Tannin .....	5 to 10 grammes.
Laudanum.....	30 to 50 drops.
Powdered gum-arabic.....	50 grammes.

The temperature of the mixture and the quantity to be injected should vary, according to the age of the patient and other circumstances, in the judgment of the physician. The most convenient time for administration of an enteroclyster is immediately following an evacuation.

It is the experience of those who have followed this method of treatment that in almost every case of cholera taken at the beginning it has proved successful in a surprising manner in arresting the diarrhœa and stopping the disease.

In the language of Ramello, "If all of those who suffer from diarrhœa in time of cholera would at once have recourse to tannic enteroclysters, the grave cases of this disease would be very rare." But the first and the second phase of the disease, in which medical treatment promises its most certain triumphs, are through neglect usually passed before the physician is called. When first seen the patient has generally advanced far toward or is already in the stage of collapse, when the system is nearly overwhelmed by the quantity of specific poison already absorbed from the intestinal canal and by the excrementitious substance retained in the economy by reason of the failure of the liver and the kidneys to perform their excretory functions, and when neither the substances swallowed *per os* nor those injected *per rectum* are longer absorbed.

In this desperate condition the warm bath repeated every hour or two may be resorted to with some prospect of benefit. But it should be supplemented by an attempt to restore to the tissues of the body the large quantities of fluids which have been lost, and to wash out from them some of the excrementitious substances which have not been eliminated. For this purpose intravenous injections have been proposed, and during the last epidemic were more or less extensively practiced, but without great success, as a rule. Another method of accomplishing the end in view, less objectionable and more easy of application, has also been proposed by Cantani, of Naples, and practiced by him and his countrymen with great success, as is reported. It has been named *hypodermoclysis*.

## HYPODERMOCLYSIS IN CHOLERA.

It is claimed that this method is neither irrational nor dangerous nor painful nor difficult nor lengthy nor inapplicable in a large number of cases. The method of hypodermoclysis is based by Cantani upon the following plausible considerations :

1. The death of cholera patients supervenes either by asphyxia in the algid period or in consequence of a tumultuous reaction in the typhoid stage, because the organism through diarrhoea and vomiting has lost a very large quantity of its aqueous constituents, and has retained or can not longer eliminate the excrementitious materials—the products of combustion and of decay—on account of suppression of the functions of the kidneys.

2. Recovery occurs when absorption is resumed, in the intestinal canal, of the fluids which furnish to the blood and to the tissues the water which is indispensable to them.

The office of the physician is therefore to introduce this water into the blood and tissues ; not being able to do so either by the stomach or by the rectum, he should have recourse to subcutaneous injections, and in this rational manner satisfy the need of the whole organism.

Cantani suggests as the most successful time for resort to hypodermoclysis the first indications of insufficiency of water in the body, such as discoloration of the skin, cramps, coldness, etc.; that is to say, in the beginning of the algid period.

The formula for the fluid used by Cantani for hypodermoclysis is, for an adult, as follows :

R Pure sodium chloride .....	80 grammes.
Sodium carbonate .....	6 grammes.
Dissolve in 2 litres of boiled water.	

The quantity to be injected each time varies, according to circumstances, from one to two and one-half litres. The temperature of the solution should be 38° C., unless that of the rectum be very low, in which case it has been sometimes raised as high as 43° C.

The apparatus required is very simple. One of the best forms consists of an ordinary fountain syringe having a long elastic tube, to the distal end of which is attached a fine-pointed metallic canula supplied with a cock.

The operation is as simple as the apparatus. The region preferred is either the mammary or the ileo-costal. A fold of the skin is raised, and the canula, previously filled with fluid, is inserted quite a distance between the skin and the subjacent fascia. The fountain of the syringe is elevated until the fluid begins to flow by gravity. In fifteen to twenty minutes one to two litres can be thus injected. During the process, the current should be interrupted at intervals by means of the cock. Upon withdrawal of the canula after completion of the operation, the tumor formed by the injected fluid should be gently rubbed, when the latter will very soon be absorbed.

The warm bath, in conjunction with hypodermoclysis, appears to exercise a powerful influence upon absorption also.

After hypodermoclysis, hypodermic injections of stimulants, often so urgently called for, especially during the stage of collapse or rigidity, become active, whilst they have before been inert.

If after a first injection the coldness and the wrinkling of the skin persist and the secretion of urine be not re-established—if, in a word, we be convinced that the tissues are not yet supplied with the water which they have lost—the operation should be repeated some hours later.

“In the majority of cases, however, after the first hypodermoclysis, if the internal losses have not been such as to be incompatible with a good reaction, the circulation is re-established, the eyes open, and are bathed once more with their natural fluids and show an expression of consciousness. Little by little the lividity of the skin diminishes, and the timbre of the voice becomes normal. In less than an hour, a person who was at the mouth of the grave is restored to life.

“The physician who knows how to use, with courage and reliance, laudanum, tannic enteroclysis, warm baths, and hypodermoclysis will have to record among the victims of cholera only those unfortunates who when he was called were already well advanced in the stage of cyanosis and collapse.”



Such are the confident expressions of an author who has repeatedly seen the marvelous results of this new practice. In summarizing the treatment he says :

“First period of cholera, improperly called *premonitory diarrhœa* : Rest in bed, warm infusions with laudanum or chlorodyne and cognac ; warm bottles to the feet, warm general baths, and *warm tannic enteroclysters*. Certain cure.

“Second period, specific or rice-form diarrhœa : Always warm baths, lemonade acidulated by chlorohydric or tannic acid, with laudanum, spirituous liquors, warm tannic enteroclysters, lumps of ice swallowed. Cure almost certain.

“Third period, vomiting, diarrhœa always more profuse, cramps and coldness, commencing cyanosis : Hypodermoclysis and warm baths, alternated with tannic enteroclysis, hypodermic injections of stimulants, revulsives externally. Very many cures.”

In the stage of typhoid reaction the skill, judgment, experience, and watchfulness of the physician are taxed to the utmost. In the selection of the line of treatment to be followed, it should be always borne in mind that we have to do with a *secondary fever of a septic character* consequent upon extensive abrasion or destruction of the mucous surfaces of the intestinal canal, and complicated by serious involvement of the liver, of the kidneys, sometimes also of the blood, and of the general nervous system.

#### FERULA SUMBUL IN CHOLERA.

According to the London Lancet, several medical experts have been sent by the Russian Government to Asia Minor to test by experiment the treatment of cholera with ferula sumbul, a plant growing in Turkestan and possessing antispasmodic properties. Musk root, as the root of this plant is called from its strong musky smell, has been used for a long time by the Russian physicians as a remedy in cholera, dysentery, and febrile diseases of a typhoid or adynamic type. Sumbul root is official in the British Pharmacopœia, and as obtained in this country is in circular pieces, consisting of transverse sections of the root, with a wrinkled epidermis of a light-brown color. It is employed as a stimulant, like the aromatic oils in general. It specially resembles valerian and musk, and is used in the same class of cases as these drugs. It will be interesting to know definitely whether sumbul possesses any special property in the treatment of cholera different from that of the other aromatic stimulants in use at the present time.

#### ANTIDOTAL TREATMENT OF CHOLERA.

Based upon the wide-spread and rational belief that the clinical symptoms of cholera infection are the visible effects of a specific chemical poison generated within the body during the development of the disease, various clinicians and physiologists have from time to time made the empirical attempt to discover a chemical or physiological antidote for this supposed poison, with the view of combatting its effects after absorption and diffusion through the system.

In this connection the views and experiences of Dr. T. Louder Brunton, it may be interesting and instructive (*Disorders of Digestion*, London, 1886), and I introduce them here:

The cause of cholera is now generally admitted to be a poison of some sort, which can be conveyed about from place to place and transmitted from one person to another, through the medium of the evacuations which either get into water and are drunk, or become dry and are taken into the mouth and nostrils in the shape of dust. Some even yet are inclined to hold that cholera results rather from peculiar atmospheric and other conditions than from the presence of a specific poison, but the fact that the disease may be conveyed from one infected locality to numerous others by a single individual, breaking out where he has stopped and passing over those places which he has only traveled through, although these may present apparently identical conditions of air, sea, and water, shows conclusively that an outbreak of the pestilence can not be due to these latter circumstances alone. Nor will the mere presence of the poison always produce cholera, for those who are exposed to contagion do not all become affected, and even those who have swallowed cholera stools in which the poison is supposed to be present in its most concentrated form have sometimes escaped with impunity. It would appear that two conditions are required, viz, the presence of a poison and the existence of a proper soil for its

development. In other words, it would seem that the poison does not produce its usual effects even when it has entered the system, unless the blood and tissues are in such a state that it can act upon them. The nature of this state we can not exactly define, but its presence seems to be due in great measure to those conditions of atmosphere and soil which some assert to be the immediate cause of the disease, but which in reality only predispose to it.

Without entering into this question at any greater length, I shall assume that cholera is caused by a specific poison acting upon an organism which has become, in some way or other, susceptible to its influence. The effects of the poison upon the body may be summed up in a few words. It produces irritability of the digestive canal, immoderate secretion from the intestines, and lessened circulation both through the lungs and through the body. Bearing in mind these actions, it is perfectly easy for any one to deduce from them all the symptoms which are observed in the state of cholera collapse.

From the irritability of the stomach and intestines there is constant vomiting and purging. The secretion from them is so profuse that the whole intestinal canal is washed clean out; the stools are no longer feculent nor even tinged with bile, but consist of the secretion alone, pure and unmixed, and resembling rice water in appearance. The blood is thus drained of its fluid parts, and the consequence is the intense thirst, which adds greatly to the sufferings of the patient. The blood itself, instead of coursing rapidly through the vessels as it does in health, stagnates in the great veins of the thorax and abdomen; the left side of the heart, instead of receiving from the lungs a full supply of well aerated blood, which it would propel through every part of the body, receives only a scanty dribble, which leaves it almost collapsed; the arteries which proceed to the body are so empty that when they are cut across hardly a drop of blood flows from them, and even when a tube is passed through the carotid artery and aorta right up to the sigmoid valves of the heart, as was done by Dieffenbach, no blood can be drawn from it. The warm blood from the interior of the body, which usually circulates in the vessels near the surface, imparting to it the plumpness, warmth, and rosy hue of health, stagnates in the abdominal veins and leaves the skin shrunken, pale, and cold, while that in the interior of the body, being no longer cooled by circulation near the surface, becomes hotter and hotter, till the internal temperature of the unfortunate patient is higher than it usually is in high fever, though his skin and breath are cold as ice. The blood which fills the small cutaneous veins being no longer driven forward by fresh supplies from the arteries, becomes completely deoxygenized and black, imparting to the surface a livid hue. So dark does the blood become that it assumes the color of bilberry juice, and the coloring matter leaves the corpuscles and tinges the serum; it still retains its power to take up oxygen and give off carbonic acid, but notwithstanding this, it passes so slowly through the pulmonary vessels that only one-third of the usual quantity of carbonic acid is given off from the lungs, and little oxygen being taken in, there is a distressing feeling of want of breath. The voice, at the same time, is hoarse, low, and weak; but this seems to be simply a consequence of the general exhaustion of the patient.

Such are the symptoms of cholera, all rising from disturbances of the circulation and excessive intestinal secretion. The remedy we seek must, therefore, be one which has the power of removing these conditions. It may be thought that the only way to do this is to eliminate from the body the poison which is producing these results; and that so long as it is still circulating in the blood any remedy which is simply intended to counteract its effects will be administered in vain. But the researches of Fraser\* and others on antagonism have shown us that the elimination of a poison is not required in order to prevent its injurious or fatal action, for the administration of an antidote will deprive it of its hurtful power; and as it is with other poisons, so may it be with that of cholera.

While thinking over this subject two years ago it occurred to me that if any poison should possess actions similar to those of the cholera poison, an antidote to it might possibly prove to be a remedy for cholera. It was by no means certain that it would do so, but still this direction seemed to be the one in which the search for a cure for cholera might be prosecuted with the greatest chance of success.

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\* Transactions of the Royal Society of Edinburgh, vol. xxvi.



The author, therefore, began to look for a drug which would produce the same changes in the circulation which he had described as occurring in cholera. His friend, Schmiedeberg, had discovered and isolated a new alkaloid from a poisonous mushroom, the *Amanita muscaria*, or *Agaricus muscarius*, and had investigated its physiological action. Among other things he noticed that when given to animals it caused great dyspnoea. At the same time the arteries became empty, so that when cut across hardly a drop of blood issued from them—the very condition already mentioned as existing in cholera. From a peculiar action which it exerts upon the heart of a frog, and which is removed by atropia, Schmiedeberg administered atropia to the warm-blooded animals suffering from the symptoms just described in the hope that it would counteract the effects of muscaria in them, just as it did in the frog. His anticipations were completely realized, and the symptoms at once disappeared after the antidote had been given. Schmiedeberg had not thought at all of contraction of the pulmonary vessels as a cause of dyspnoea; he attributed it rather to excitement of the nervous center in the medulla oblongata which regulates the respiratory movements, and the effect of the atropia in removing the dyspnoea greatly puzzled him, for atropia itself excites the nervous center, and ought, according to his supposition, to have increased instead of removing the breathlessness. Brunton experimented with a small amount of the alkaloid sent him, and found, as he had expected, that the dyspnoea of muscaria is due to spasm of the pulmonary arteries. He found also, as Schmiedeberg had pointed out, that atropia acts as a prompt antidote for this action of muscaria. And he reasoned that if the theory of Parks and Johnson that the circulatory troubles and the dyspnoea in cholera are due to spasmodic contraction of the arterioles of the lungs be correct, then in atropia we ought to have a most valuable remedy in cholera. This expectation was further apparently supported by the reported experience of Dr. Saunders, of Paducah, Kentucky.\*

But Brunton holds that if there is a contraction of the arterioles of the lungs in cholera, there is also a wide dilatation of the large veins of the abdomen; that in fact this condition of the veins will in many instances more satisfactorily explain the clinical and post-mortem findings concerning the condition of the circulatory system in cholera than will Parkes's theory of arteriole spasm in the lungs alone. Brunton suggests the use of atropia as a possible antidote to the cholera poison, but with considerable doubt of its completeness. On account of the similarity which is presumed to exist between the state of the large abdominal veins in shocks after severe injuries and their condition in cholera, Brunton recommends a trial of digitalis, because injections of this drug have proved very useful in the former.

"But any search for a remedy for cholera will be very imperfect if the action of any proposed medicine on the circulation alone is considered, and its effect on the intestinal secretion left out of account. For the latter is probably even more important than the former, and it is not unfrequently present when the changes in the circulation are either slight or absent altogether. I have therefore endeavored to discover the action of atropia on the intestinal secretion."

After several ingenious experiments Brunton arrived at the deduction that the intestinal secretion in cholera is the result of a paralysis rather than an irritation of the nerves, and he found that atropia exercises no influence over it.

"This result is disappointing and renders the use of atropia in cholera somewhat doubtful, for although the secretion caused by the sulphate of magnesia may be due to irritation, while in cholera it is due to paralysis of the nerves, yet if atropia can not stop it in the former case it is much less likely to arrest it in the latter.

"The points in this paper to which I wish to direct special attention, are :

"(1) Assuming Parkes and Johnson's theory to be correct, and the impeded circulation in cholera to be really due, either in whole or in part, to obstruction in the pulmonary vessels, my experiments with atropia in muscaria poisoning show that it is likely to prove beneficial to a certain extent in cholera, and since it has been found empirically to be useful in this disease, it ought to receive a fair trial at the hands of the medical profession.

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\* American Practitioner, July, 1873.

“(2) The fact that the right side of the heart is not dilated during life in cholera patients, as well as the uselessness of nitrite of amyl, which dilates the pulmonary vessels, shows that Parkes and Johnson’s theory is imperfect, and that one of the most important pathological conditions in cholera collapse consists in dilatation of the thoracic and abdominal veins. Any remedy which is to be useful in cholera must have the power of counteracting this condition, and the administration of digitalis in cholera collapse may be useful.

“(3) The profuse secretion from the bowels in cholera is due to paralysis of some of the intestinal nerves, and a remedy which will arrest it is still a desideratum.”

These attempts by Brunton to neutralize the noxious effects of the specific poison after it has reached the general blood circulation seem to indicate that the physiological antidote had not been found at the date of publication of his experiments. Of this order of efforts at antidotal therapeutics, is the practice proposed by Mr. Perroux, of Calcutta, in recent correspondence with the Department of State, in which that gentleman relates the successful employment (intravenous) of the venom of the *cobra di capello* by some tribes in the north of India as an antidote, in the lethal stage of cholera, of the poison of that disease.

#### ANTISEPTIC TREATMENT OF CHOLERA.

The recent experiments of Löwenthal (see page 631), looking to the cure of Asiatic cholera through the antiseptic action of salol upon the cholera bacilli after they have found entrance into the intestinal canal and already begun their harmful work, are of a different order and aim at preventing the poisoning of the blood and general tissue of the body by arresting the generation of the poison elaborated in the intestinal canal by the development of the cholera microbes. Recent reports from India of the employment of that intestinal antiseptic in actual cases of the disease speak very favorably of the powerful specific action of salol, and furnish some basis for the hope that a safe and reliable remedy and prophylactic agent may have at last been found.

Finally, the reader has seen numerous suggestions and proofs among the foregoing pages concerning the existence of a certain degree of immunity conferred by exposure to the infection as well as by experiencing an actual attack of cholera. Furthermore, it has been seen that there is no insignificant amount of experimental evidence to demonstrate the artificial production of immunity against the naturally fatal effects of virulent cultures of the comma bacillus of Koch, which microbe I hold can now be safely accepted as the active cause of cholera, an opinion decidedly strengthened by the recent experiments of Löwenthal and Gamaleila, and by the very striking results of the anti-choleraic human inoculations in Spain. It has been shown that the chemical products of virulent cultures of the bacilli of cholera as well as the chemical products of certain other specific pathogenic bacteria possess the etiological and prophylactic powers of the living bacteria. In view of the progress of recent discoveries in this direction it does not seem at all improbable that in the near future the chemical poison of cholera elaborated during the artificial growth and development of the comma bacillus of Koch, and extracted in a pure form, may become our most potent and ready weapon of defense against the devastations of cholera infection.





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## CONCEPTUACIÓN.

	MOREDA.			NAVARIDAS.			OCIO.			OYÓN.		
	Varones.	Hembras.	TOTAL.	Varones.	Hembras.	TOTAL.	Varones.	Hembras.	TOTAL.	Varones.	Hembras.	TOTAL.
<i>Total de Invidiosos. . . . .</i>	4	2	6	12	9	21	7	10	17	74	88	162
<b>DEFUNCIONES CLASIFICADAS POR EDADES</b>												
De. . . . . 0 á 3 años.	1	»	1	2	»	2	»	»	»	7	4	11
» más de 3 á 6 »	»	»	»	2	»	2	»	»	»	3	2	5
» » 6 á 13 »	»	»	»	»	»	»	»	»	»	3	1	4
» » 13 á 20 »	»	»	»	»	»	»	1	1	2	1	2	3
» » 20 á 25 »	»	»	»	»	2	2	»	»	»	1	»	1
» » 25 á 40 »	»	»	»	»	»	»	1	»	1	2	6	8
» » 40 á 60 »	»	1	1	1	»	1	1	»	1	4	4	8
» » 60	»	»	»	»	»	»	»	»	»	3	3	6
<b>POR ESTADOS</b>												
Solteros. . . . .	1	»	1	4	»	4	1	1	2	15	10	25
Casados. . . . .	»	1	1	1	2	3	2	»	2	8	9	17
Viudos. . . . .	»	»	»	»	»	»	»	»	»	1	3	4
<b>POR PROFESIONES</b>												
Jornaleros. . . . .	»	»	»	»	»	»	»	»	»	11	1	12
Artesanos. . . . .	1	1	2	»	»	»	»	»	»	»	»	»
Labradores. . . . .	»	»	»	1	»	1	1	1	2	2	3	5
Empleados. . . . .	»	»	»	»	»	»	»	»	»	1	»	1
Propietarios rentistas, etc.	»	»	»	»	»	»	»	»	»	»	»	»
Otras profesiones. . . . .	»	»	»	4	2	6	2	»	2	10	18	28
<i>Total general de Fallecidos</i>	1	1	2	5	2	7	3	1	4	24	22	46
Población según Censo de 1877. . . . .	565			337			249			934		
Fechas en que la epidemia. {	Comenzó . . .			23 Septiembre.			19 Agosto.			31 Agosto.		
	Terminó. . .			6 Octubre.			3 Septiembre.			15 Septiembre.		
Días de duración (N.º de)	9			14			16			16		
Intensidad diaria ó tér- mino medio de morta- lidad. . . . .	0'22			0'50.			0'25			2'87		
Proporción to- tal por ciento {	0'35			2'07			1'60			4'92		
	en relación con. . . . . los invadidos.			33'33			23'53			28'39		



## PARTIDO JUDICIAL DE LÁGUARDIA.

BAÑOS DE EBRO.			BARRIOBUSTO.			BERNEDO.			LA BASTIDA.			LA PUEBLA DE LA BARCA.		
Varones.	Hembras.	TOTAL.	Varones.	Hembras.	TOTAL.	Varones.	Hembras.	TOTAL.	Varones.	Hembras.	TOTAL.	Varones.	Hembras.	TOTAL.
64	72	136	25	36	61	2	1	3	33	49	82	89	117	206
3	4	7	3	3	6	»	»	»	1	1	2	8	10	18
7	2	9	»	1	1	»	»	»	»	1	1	3	5	8
5	»	5	»	1	1	»	»	»	»	»	»	4	5	9
1	»	1	»	»	»	»	»	»	»	»	»	2	3	5
5	4	9	»	3	3	»	»	»	»	1	1	3	2	5
2	5	7	3	1	4	»	»	»	1	2	3	10	11	21
3	2	5	3	2	5	»	»	»	3	2	5	10	16	26
5	11	16	3	3	6	1	»	1	»	7	7	6	6	12
20	6	26	3	5	8	»	»	»	1	2	3	18	22	40
8	13	21	7	5	12	1	»	1	4	6	10	25	28	53
3	9	12	2	4	6	»	»	»	»	6	6	3	8	11
26	26	52	»	»	»	»	»	»	1	9	10	16	1	17
»	»	»	1	»	1	1	»	1	1	»	1	3	»	3
4	2	6	11	14	25	»	»	»	»	1	1	11	»	11
1	»	1	»	»	»	»	»	»	»	»	»	»	»	»
»	»	»	»	»	»	»	»	»	1	2	3	»	»	»
»	»	»	»	»	»	»	»	»	2	2	4	16	57	73
31	28	59	12	14	26	1	»	1	5	14	19	46	58	104
382			377			682			1.787			742		
2 Septiembre.			7 Septiembre.			8 Septiembre.			8 Octubre.			6 Septiembre.		
14 id.			5 Octubre.			16 id.			23 id.			11 Octubre.		
13			29			9			16			36		
4'54			0'90			0'11			1'19			2'89		
15'44			6'89			0'15			1'06			14'02		
43'88			42'62			33'33			23'17			50'48		





